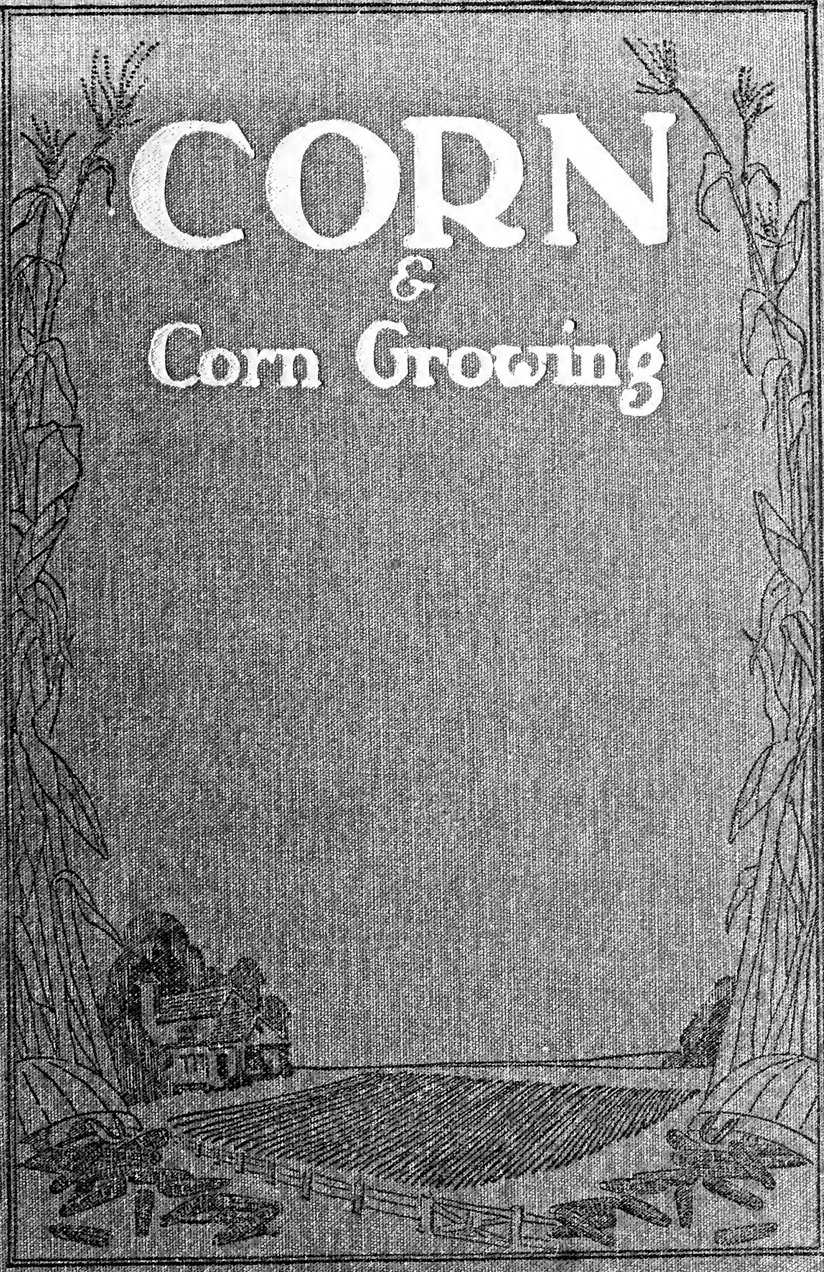
CORN
&
Corn Growing



CORN AND CORN-GROWING

BY

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AND

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FULLY ILLUSTRATED

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PREFACE

This text on corn is based primarily on a teaching outline of a complete term course on corn in an agricultural college. We have attempted to include every practical thing related to corn. The text is designed not only for college and Smith-Hughes instructors, but also for experiment station workers, corn breeders and practical farmers who are interested in growing more and better corn. Teachers may think that the order in which the chapters are arranged is a little unusual. It has been found on experience, however, that this order gives excellent results and holds the interests of the students much better than is the case when the botany and classification of corn are discussed early in the book.

Although throughout the text we are presenting the best knowledge now available, we realize that new scientific discoveries and shifting economic conditions may change things considerably in the future. We want to make the student feel himself a part of this unfolding instead of having him learn things in the belief that they are absolutely true now and for all time.

In the preparation of the manuscript liberal use has been made of experiment station and United States Department of Agriculture publications, both with and without credit. Much credit is due to the early and present members of the Farm Crops Department of the Iowa State College for the aid given in the early stages of the preparation of the manuscript. Others have given valuable assistance in the preparation of the completed text.

H. A. WALLACE.
E. N. BRESSMAN.

Sept. 1, 1923.

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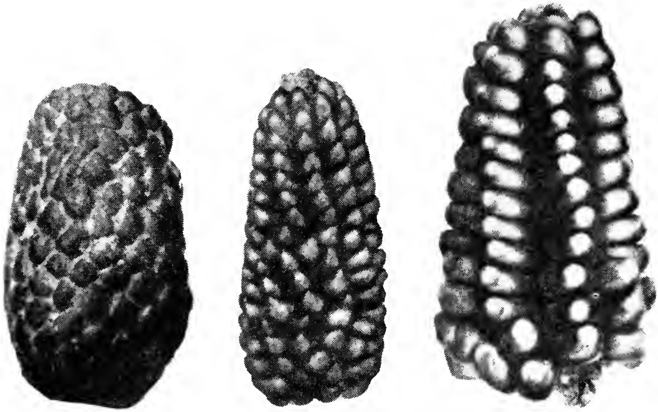
CHAPTER 1

HISTORY OF CORN

CORN is one of the few standard crops that originated in America. Early writers disagreed as to the place of origin of corn, some maintaining that it came from eastern Asia; others that it came from Africa, while still others said it was of American origin. The latter is now generally accepted as the true theory. The main reason for the acceptance of this theory is that no mention is made of corn in the early writings,



On left fossil ear discovered in Peru and on right modern types of corn as grown in Peru. (Courtesy of Journal of Heredity.)

and, with one possible exception, no mention is made of it until the discovery of America, in 1492. This possible exception is a tradition of the Norsemen that they found the grain being cultivated by the Indians when these explorers landed on the western continent, in 1002. Another reason for the belief that corn originated in America is that it was generally cultivated by the natives when Columbus first discovered the continent. Its antiquity in America is also indicated by the specimens found in the ruins of the Cliff Dwellers and Mound Builders. Highland Peru and southern Mexico are the two places which have the best

claim to being the original home of corn. The fossil ear found in 1914 in Peru by Doctor W. F. Parks, indicates Peru as the place of origin of corn. The ear, which is doubtless several thousand years old, is much like some of the present-day varieties grown in Peru. The specimen is three inches in length, tapered, and rounded on the butt end. The kernels are somewhat like those of rice popcorn.

According to Harshberger, the Indians probably first found the plant in Mexico, in the region above 4,500 feet altitude and south of 20 degrees north latitude and north of the river Coatzacoalcos and in the isthmus of Tehuantepec. It probably reached the Rio Grande about 700 A. D., and by the year 1000 had reached the coast of Maine. These dates are more definite than most writers give, but the evidence of wild grasses related to corn growing in southern Mexico suggests Mexico rather than Peru as the place of origin.

Originated From Wild Grass

In southern Mexico there are two native wild grasses, gama grass and teosinte, both of which are closely related to corn. Corn has never been found growing wild, and many are of the opinion that corn has been developed from teosinte, which resembles corn more closely than any other wild grass. Other writers think that both corn and teosinte developed many thousands of years ago from a common ancestor, possibly from such a grass as perennial teosinte, recently found in southern Mexico. Others think that annual teosinte is a cross of corn and perennial teosinte.

Teosinte has a tassel just like corn, and the seeds are enclosed by husks and borne in the axils of the leaves. The teosinte ear (there is no cob) is about three inches long and is composed of five to ten kernels arranged end to end. Teosinte readily crosses with corn, which again suggests that the two plants have a common ancestry or that corn originated from teosinte.

Corn and teosinte both doubtless trace back to a plant resembling gama grass, a plant having a tassel at the top and tassel-like structures on long, lateral branches—all tassels bearing male flowers on the upper part of the tassel and female flowers on the lower part. In the process of evolution and diversification, the tassels at the top came to produce only pollen and the tassels on the lateral branches only seeds, and at the same time the lateral branches were shortened until the tassels were enclosed by husks. It is also probable that in this evolution the lateral tassel developed into an ear. Nature has been aided by man, of course, in the selection of our present types of corn.

Early Types of Corn

Most writers speak of flint, soft, gourdseed and sweet types of corn as being grown by the Indians and the early settlers. Indications

Teosinte tassel and ear spike. The teosinte ear spike is covered with husks and each kernel has a silk just as with corn. (Courtesy of Journal of Heredity.)

are that the dent varieties of today are the result of both accidental and intentional crossing of gourdseed and flint types. This is discussed fully in Chapter 26.

The Atlantic Coast farmers, from 1800 to 1840, made a real effort to get high yielding strains of corn. The farm papers of 1819 to 1822 tell of several instances of getting Maha (undoubtedly Omaha Indian) corn from Council Bluffs—now a part of Iowa. This corn was an eight-row soft corn type, and several of the eastern farmers claimed yields of more than 100 bushels to the acre. The Sioux yellow, ten to twelve-row flint corn was introduced from the west by several growers, and there were several introductions of a Canadian flint corn. These introductions, together with the local varieties, are probably found to some extent in all of our present-day varieties, and help to explain the heterogeneous nature of our present-day types.

The Iowa State Agricultural Society report of 1858 says: "A great many varieties of corn are cultivated, and it would be hard to tell which is the best, as farmers entertain different opinions." Most of the varieties were dents, according to the report.

J. M. Chambers, of Linn county, Iowa, in 1858 wrote: "The yellow flint and the Virginia gourdseed are the principal varieties."

Early History in America

Early explorers in America mention the large fields of corn cultivated by the Indians, and remarked about the slowness of Europe to adopt this new grain, which they considered so valuable. In 1498, Columbus reported his brother as having passed through eighteen miles of corn on the Isthmus; in 1605, Champlain saw a field of corn at the mouth of the Kennebec river; in 1609, Hudson saw many fields along the Hudson river, and in 1620, Captain Miles Standish reported a field of 500 acres in Massachusetts that had been cropped the year previous. Drawings made by Hernandez of corn which he found in Mexico about 1600, show the plant with three or four ears on the stalks, and ears with eight or ten rows.

Thomas Hariot, a member of the ill-fated Virginia colony of 1585, wrote in 1588 what is probably the first extended English description of corn as grown in what now is the United States. He stated: "Pagatour, a kinde of graine so called by the inhabitants; the same in the West Indies is called Mayse. . . . The graine is about the bignesse of our ordinary English peaze, and not much different in forme and shape, but of diuers colors; some white, some red, some yellow, and some blue. All of them yeelde a very white sweete flowre; being used according to his kind it maketh a very goode bread."

On November 16, 1620, a group of Pilgrims landed on the Plymouth coast and spied five Indians whom they followed all that day. The next morning, they "found new stubble where Indian corn had been planted the same year." Near a deserted house "heaps of sand newly

paddled with hands which they digged up and found in them divers fair Indian corn in baskets, some whereof was in ears, fair and good, of divers colors, which seemed to them a goodly sight having seen none before."

The most important history of corn in this country, as far as the white man is concerned, began with the settlement of Jamestown in 1607. The colonists had a hard time to keep from starvation; and had it not been for the corn obtained from the Indians, the colony would probably have resulted in failure. The Indians taught the colonists how to prepare the ground and plant the corn. The trees were girdled, the ground stirred and the grain planted in hills three or more feet apart. In places on the New England coast, it was necessary to fertilize the ground before it would produce a crop. The Indians showed the colonists how to fertilize with fish. Herring or shad, which came up the streams by the thousands in the spring to spawn, were caught; and one fish was placed in each hill of corn. One writer of the time said that it took about a thousand fish to plant an acre of corn, and without fish no corn was planted. He also stated that an acre of corn planted with fish yielded as much as three acres planted without.

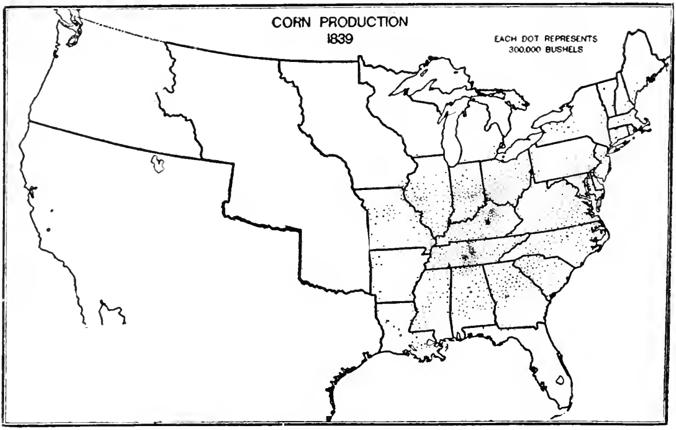
Corn formed such an important crop with these colonists that many laws were passed regulating the minimum amount to be grown and the methods of caring for it. It was even enacted that all dogs should be tied by the leg during planting time, to prevent their eating the fish. Other laws were passed providing for the payment of taxes in corn. The price when used for this purpose was fixed by law. One writer of the time says that the reason so much corn was grown rather than wheat was because wheat would not grow and mature. The failure of wheat was, of course, due to the growing of unacclimated English varieties.

The cultivation of corn in America increased rapidly. In 1609, it is reported that thirty acres were planted. In 1650, there is a record of 600 bushels being exported from Savannah, and from that date on there were exports from the colonists almost annually. In 1770, the total exports were 578,349 bushels, and in 1800 this was increased to 2,032,435 bushels.

Later History in America

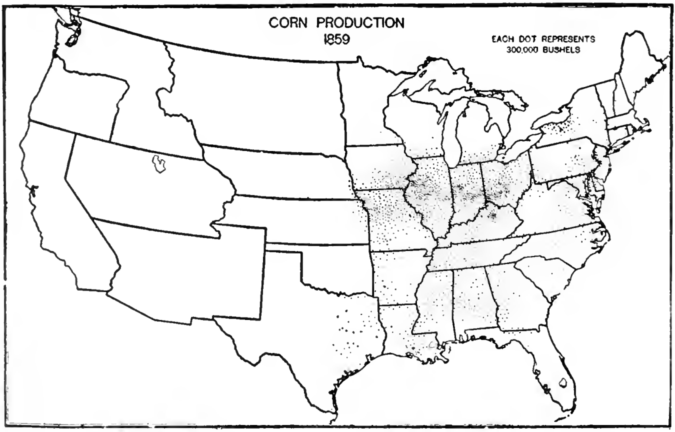
With the opening of the Mississippi valley, the production of corn increased by leaps and bounds. The growers found that corn was peculiarly adapted to this region, and it at once became the principal crop. This section soon became world-famous as the "Corn Belt." About 1870 began the increased use of farm machinery and improved varieties of corn so that a man could tend a much larger area and at the same time obtain larger yields. The 1839, 1859 and 1919 maps of corn production in the United States illustrate very vividly how recently the Corn Belt has come into its own.

MAP I.



In 1839 Tennessee and Kentucky were the leading corn states and the total production of the entire United States was less than the normal crop of Iowa today. (Courtesy of U. S. Department of Agriculture.)

MAP II.



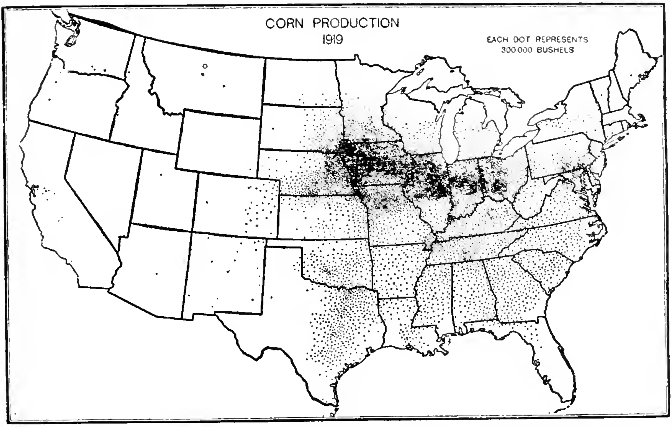
From 1839 to 1859 the center of corn production moved north and west and the corn belt as we now know it began to take shape. Illinois and Ohio were the leading corn states in 1859. (Courtesy of U. S. Dept. of Agriculture.)

Schmidt says that during the fifty-year period from 1849 to 1899 the center of corn production moved north only five miles, whereas at the same time the center of production had moved westward 480 miles. The center of corn production is now near the Mississippi river, not far from Keokuk, Iowa.

History in the Old World

Soon after the New World was discovered, corn from the West Indies and Peru was introduced into Spain, Italy, southeastern Europe, India, Africa and China. During the sixteenth century, corn growing spread

MAP III.



In 1919 Iowa was the first corn state and the center of corn production was not far from Keokuk, Iowa. (Courtesy of U. S. Dept. of Agriculture.)

with exceeding rapidity over the temperate and sub-tropical regions of the entire world. In no place, however, with the possible exception of a rather limited area in the Balkan states, did corn come to dominate the entire agriculture of a region as it does in the Corn Belt of the United States. Much of the corn grown in Europe has descended from the tropical flints of the West Indies. In the nineteenth century, however, a few Corn Belt varieties were introduced into Europe, but generally speaking, corn as grown in the Corn Belt has met with very little favor anywhere outside of the Corn Belt. For further information concerning corn outside of the Corn Belt, see Chapter 38.

CHAPTER 2

THE IMPORTANCE OF CORN

CORN produces more food value per acre than any other crop. A 35-bushel crop gives nearly 150 pounds of protein and more than 3,000,000 units of energy. Corn is becoming more and more popular as a human food. It is the main cereal food of the cotton belt. Corn, consumed directly and in the form of meat, dairy and poultry products, is the principal source of food of the American people.

The corn crop played a vital part in the great World war. In response to widespread appeals, the United States acreage in 1917 was increased more than 10 per cent, and approximated 117,000,000 acres. The crop of 3,065,000,000 bushels was next to the largest ever harvested. If this crop had been loaded on wagons, each containing 50 bushels and occupying 20 feet of space, these wagons, placed end to end, would make a line long enough to encircle the globe nine and one-half times. During the war and the years immediately following, the United States sent Europe an average of 50,000,000 bushels more corn annually than was customary before the war. Corn, both in the form of corn and of hog products, played an absolutely decisive part in helping the Allies to win the World war and in keeping hundreds of thousands of Europeans from starving after the war was over.

Corn has never been used as extensively for human food as wheat. However, millions of the poorer classes in Mexico, Italy, Argentina, Spain and the Balkan states eat far more corn than wheat.

Value in the United States

The value of corn in the agriculture of the United States is well known. In acreage, in multiplicity of uses, in production and in value, it exceeds any other cultivated crop. In the decade, 1908 to 1917, the acreage devoted to corn in this country was 4.8 per cent greater than the combined acreage of the crops of wheat, oats, barley, rye, rice, buckwheat and flax. The value of the corn crop for the same period was 24.3 per cent more than the combined values of these crops.

Eventually, the manufacture of corn products in the United States will equal or exceed the meat packing industry. Even now, more than one hundred million bushels of corn every year are used in the manufacture of such products as starch, corn syrup and corn oil. Corn is one of the greatest potential sources of the alcohol which will doubtless be needed to run our automobiles when eventually the crude petroleum supply is exhausted.

Valuable as a sustainer of life among primitive peoples in peace

and war, corn, ever since the early days of the Jamestown and Plymouth colonies, has bulked large in the white man's existence on this continent. There is no indication that it will ever be otherwise

In the Corn Belt

Corn is the basis of wealth in the agricultural region known as the Corn Belt—Iowa, Illinois, Ohio, Indiana, eastern Nebraska, southeastern South Dakota, northern Missouri, southern Minnesota and eastern Kansas. One hundred and forty million acres of the richest land in the world lie in this Corn Belt of the United States, of which Davenport, Iowa, is not far from the center of production. As may be judged from Map 3, in Chapter 1, the Corn Belt extends about 100 miles west into Nebraska, 75 miles northwest into South Dakota, 50 miles north into Minnesota and eastward through Iowa, the northern two-thirds of Illinois, Indiana and the western half of Ohio. This region is the Corn Belt as it exists in the third decade of the twentieth century. As time goes on, it may shift a little to the north.

Of the one hundred and forty million acres in the American Corn Belt, about eighty-five million acres are plow land, and of this plow land about one-half, or forty million acres, are put into corn. Roughly, twenty million acres are in tame grass meadow and twenty million acres in oats and wheat.

It is corn that enables these middle-western states to produce such a surplus of pork and beef. The good homes, high land values, and prosperity of the Corn Belt are a direct outcome of the wealth that the corn crop brings to this region. The corn crop of the Corn Belt is the world's greatest bulwark against famine. In times of need, a part of the crop may be diverted from its customary use as an animal food to its more economical use as a human food.

During the spring, summer and fall, the Corn Belt farmer spends nearly three-fourths of his man and horse labor on corn. He puts twice as much time on this crop as on all of his other crops put together. Corn is at the center of Corn Belt agriculture. Wheat, oats and hay are grown chiefly to rest the land in preparation for more corn and to use farm labor at seasons of the year when it can not be employed in growing corn.

The Corn Belt farmer feeds nearly half of his corn to hogs. It is only in rather limited areas, as in central Illinois and parts of northwestern Iowa, that it is customary to ship the greater part of the corn to market in the form of grain. In all sections, one-sixth to one-fourth of the crop is kept at home to feed to horses. This part of the crop is, in a sense, just as much fuel as the gasoline used to run a tractor. Roughly, one-fifth of the Corn Belt corn is sold in the form of fat cattle, dairy products, chickens and eggs. For decades to come, the greater part of the corn of the Corn Belt must be sent to market in the form of live stock or live stock products. But after the population of the United

States passes 150,000,000, there will be an ever-increasing percentage of corn consumed by people and a smaller percentage consumed by fat cattle and fat hogs.

The Corn Belt of the United States is the only place in the world where there is such a large area of fertile land favored by a rainfall of 10 to 18 inches during the four months following corn planting and an average mean temperature during the thirty days centering around tasseling time of 70 to 80 degrees. The only close approach is in north-central Argentina, in the provinces of Buenos Aires, Santa Fe, Entre Rios and Cordoba. And in this possible corn belt of Argentina, winter wheat, alfalfa and flax are so profitable and the chance of devastating summer drouth is so great that there probably never will be more than one-half as much corn grown as in the American corn belt.

CHAPTER 3

CORN AS AFFECTED BY TEMPERATURE AND RAINFALL

CORN requires abundant moisture and a moderately high temperature if it is to make its best growth. Laboratory experiments indicate that when plenty of moisture is available, a temperature of about 90 degrees is most favorable both for germination and growth. Growth stops altogether at temperatures of below 40 degrees or above 118 degrees.

Temperature for Germination

In most corn growing sections, the temperature during the week following planting is around 60 to 65 degrees, and under such a temperature corn usually appears above ground in eight or ten days. When the ground is cold and the temperature averages 50 to 55 degrees, it usually takes eighteen or twenty days for the corn to come up. When the temperature is less than 55 degrees, it seems that the slowly sprouting corn kernels are very susceptible to root rot infections; whereas, when the temperature is above 60 degrees the kernels are much more resistant. If the soil is warm and moist and the corn is planted shallow, a temperature of 70 degrees will bring it above ground in five or six days. In the central part of the Corn Belt, yield and temperature records indicate that a mean temperature of 55 degrees or less during May tends to reduce the yield by about 15 per cent. A temperature of 56 to 58 degrees will not ordinarily cut the yield by more than 3 or 4 per cent, unless accompanied by heavy rains and prolonged cloudy weather.

Temperature and Rainfall During June

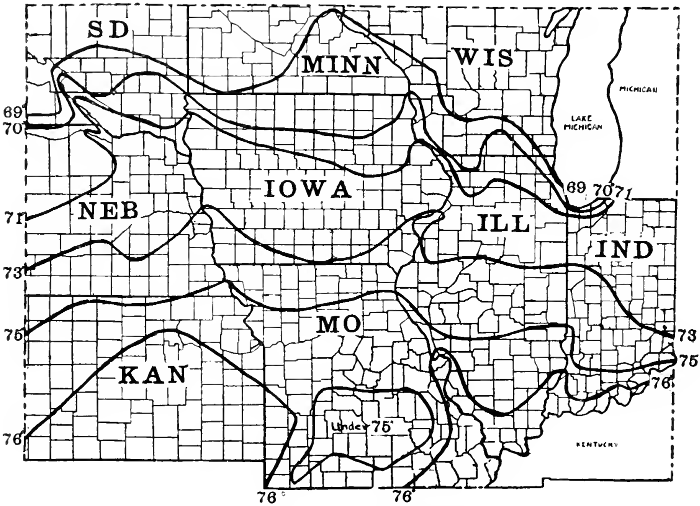
From the time the corn comes up until it reaches a height of three feet, it is necessary under practical farm conditions to give three or four cultivations, in order to kill the weeds. This can be accomplished most effectively when June is rather hot and dry. A mean temperature of 70 to 72 degrees in June, with two to four inches of rain, seems to be ideal. A mean temperature of more than 75 degrees for the month of June is so often accompanied by exceedingly dry weather, not only in June but also in July, that it is a matter of history that years of exceedingly hot Junes are usually years of below-average corn crops.

July Weather and Corn Yield

In Ohio, Indiana, Illinois, Missouri, Kansas, Nebraska and southern Iowa, the rainfall and temperature during the ten days before and the twenty days following tasseling time have more to do with corn yield than the weather at any other period. Ideally, there should be four or

five inches of rainfall during this thirty-day period, and the mean temperature should average from 72 to 74 degrees. Corn appreciates mean temperatures as high as 85 degrees, but as a practical proposition, mean temperatures above 75 degrees nearly always lower the yield for the reason that such temperatures cause the corn plants to transpire water more rapidly than they can take it up from the ground. This might not be true under irrigation, but in the Corn Belt, mean temperatures above 75 degrees are usually accompanied by drouth. It is also true that a drouth which would cause very little bother at 70 degrees may be a serious matter at 80 degrees, for it has been found at the Nebraska station that a full-grown corn plant will transpire daily

MAP IV.



Average temperature isotherms during June, July, and August in the corn belt. The most productive corn land is north of the 75-degree line and south of the 69-degree line. Only in southwestern Minnesota is there really good corn land somewhat north of the 69-degree line. The breeding of high yielding early varieties may possibly push the northern limit of the Corn Belt beyond the 69-degree line.

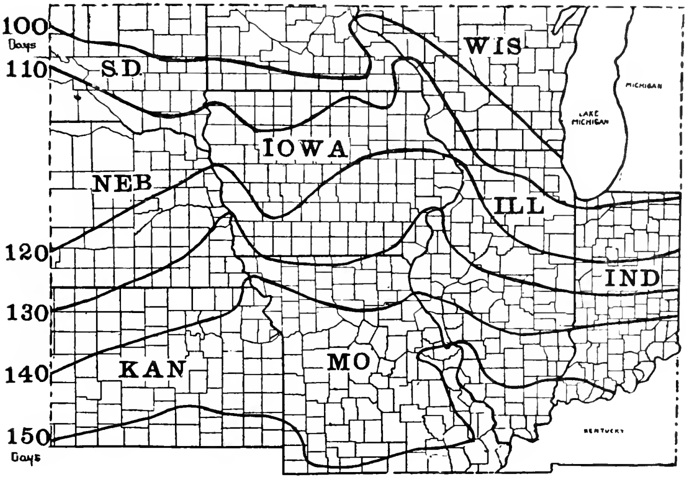
about four pounds of water at a mean temperature of 70 degrees, whereas at 80 degrees it will transpire about seven pounds.

During this thirty-day period, on land capable of producing forty bushels per acre under favorable conditions, each degree the mean temperature averages above 74 degrees cuts the corn yield by about 1.2 bushels per acre, and each inch the rainfall is below four inches cuts the yield by two bushels. For instance, with land yielding forty bush-

els per acre under the best conditions, if the corn starts to tassel on July 18 and the temperature from July 8 to August 7 averages 78 degrees and the rainfall totals two inches, the indicated yield would be forty bushels minus 4.8 bushels because of high temperature and four bushels because of drouth, or 31.2 bushels.

A general one-inch rain during late July often increases the prospective crop of the Corn Belt states by two or three bushels per acre, or by a total of over 100,000,000 bushels. Some people have therefore spoken of such a rain as worth millions of dollars to the farmers. As

MAP V.



Number of days from time temperature normally rises above 61 degrees in spring until it goes below 65 degrees in the fall. This map, together with Map IV, indicates fairly accurately where the early maturing strains are required. In northeastern Illinois much earlier varieties are required than in the same latitude in Iowa.

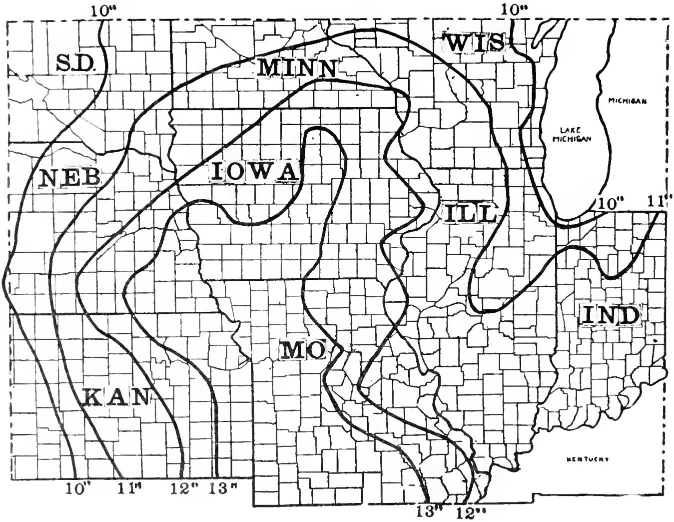
a matter of fact, December future corn prices as set by the Chicago Board of Trade during July and early August reflect these rains in such a way as to leave the total prospective value of the new crop changed but little. The rain which increases the prospective corn crop of the Corn Belt by 100,000,000 bushels, or by 7 per cent, will also lower December corn futures prices by 6 to 12 per cent. The July and early August rains which add 100,000,000 bushels to the coming crop of the Corn Belt usually result in the new corn being priced 4 or 5 cents a bushel cheaper, or enough to make the total value actually somewhat less than if the rain had not come. It is the corn product manufacturers,

exporters and stockmen who buy more corn than they raise, who benefit by the July and August rains which increase the corn crop. And, of course, it is always true that those corn sections which receive heavy July rains when the Corn Belt generally is hot and dry, benefit enormously at the expense of their less fortunate neighbors.

December Future Corn Prices and July Weather

Generally speaking, the Chicago December future corn price, as quoted day by day during July and August in the daily papers, is the best measure for the average farmer of how the new corn crop of the entire Corn Belt is being treated by the weather. If on July 30 the

MAP VI.



Average inches of rainfall in three summer months of June, July, and August.

December future price is 6 cents a bushel higher than on July 20, it is an indication that there has been practically no rain anywhere in the Corn Belt during the past ten days. If the price during this period has dropped by 2 cents a bushel, it is almost certain that there have been abundant, well-distributed rains over the greater part of the Corn Belt. Sometimes December corn futures during July and August are affected to some extent by business conditions and by wheat prices, but as a rule they move up and down in sympathy with Corn Belt weather and very little else.

Northern Iowa and southern Minnesota differ from the central part of the Corn Belt in that they are more likely to be damaged by cold and wet during May and June than by heat and drouth during July. It is only in years of exceptional drouth, like 1894 or 1901, that the northern part of the Corn Belt is likely to suffer much from July weather. Even in such years, the corn of the northern Corn Belt is usually not so very far below normal, whereas there is a great shortage in the central and southern parts of the Corn Belt. The net result, as a rule, of dry, hot July weather, so far as northern corn farmers are concerned, is prosperity at the expense of the corn farmers further south. On the other hand, cold, wet summers like 1915 and 1917 hurt the corn yields in the north and boost them south of central Iowa.

From a commercial standpoint, drouth and heat during July and early August have much more effect on the corn market than cold and wet at any time of the year.

August Weather

Over most of the Corn Belt, heat and drouth during the first half of August are almost as likely to hurt the corn crop as heat and drouth in July. Missouri, Nebraska and Kansas corn is especially susceptible to heat damage during the first half of August. North of central Iowa, however, the corn yield is more likely to be damaged by cold weather in August than by hot weather. August weather averaging below 69 degrees seems to damage the corn crop in northern Iowa and southern Minnesota, especially in years when the May, June and July weather has also been a little cooler than normal. The ideal August weather is a temperature of 72 or 73 degrees and a rainfall of four or five inches.

After August 20, the weather usually has very little significance. The corn plant at this time is manufacturing and storing sugar and starch much more rapidly than earlier in the season. Nevertheless, after thirty days have lapsed following tasseling, it seems that moderately dry weather does no damage. Rainfall is important while the young corn kernels are just forming, but for some reason is not so necessary when the corn plant is most actively at work storing food in these kernels during late August.

Frost

Frost has far less effect on the corn crop than most people think. In a season which has been unusually cool throughout, like 1915 or 1917, a September frost may cause much soft corn north of southern Iowa. Occasionally, as was the case in 1920, unusually warm September weather enables the corn crop to avoid the frost damage which seemed almost inevitable. It is only rarely that frost causes any widespread damage to corn. As a rule, most corn is sufficiently matured to withstand

frost damage two or three weeks before killing frost actually comes. Frost damage is never reflected in the price of corn on the terminal markets in the same way as heat and drouth damage.

Heat and Rapidity of Growth

While mean temperatures above 74 degrees during the twenty days following tasseling time seem to harm the corn crop, it is also true that previous to tasseling time the rapidity with which the corn grows depends largely on the temperature. During June and early July, corn grows twice as fast on those days when the mean temperature is 78 degrees as it will when the mean temperature is only 62 degrees. A 75-degree mean results in about 25 per cent faster growth than 70 degrees. A number of years ago, at the Pennsylvania station they found that during the three weeks preceding tasseling time there was a tendency for corn to grow in twenty-four hours at the following rates at varying mean temperatures:

65 degrees	3.2 inches
70 degrees	4.1 inches
72 degrees	4.5 inches
75 degrees	5.1 inches
78 degrees	5.4 inches

The average temperature during the fifty or sixty days following planting time is the chief influence determining just when a given variety of corn will tassel. With the ordinary 115-day strain of such varieties as Reid Yellow Dent, the following temperatures during the sixty days following planting result in the varying lengths of time till tasseling about as follows:

68 degrees	74 days from planting to tasseling
70 degrees	66 days from planting to tasseling
73 degrees	54 days from planting to tasseling

With a so-called ninety-day strain, the corresponding table, based on temperatures during the forty-five days following planting time, is as follows:

67 degrees	59 days from planting to tasseling
69 degrees	51 days from planting to tasseling
71 degrees	43 days from planting to tasseling

After tasseling starts, heat no longer plays such an important part. The number of days from tasseling until ripe does not vary with the heat in the same clear-cut fashion as the number of days from planting to tasseling.

Extremely high temperatures (above 95 degrees during the heat of the day) may kill the pollen within an hour or two after it is shed and thus cause poor pollination if the high temperatures are continued day after day at the time the pollen is flying. The storing of food in the corn kernel during late July and August is an altogether different

process than the rapid growing of the corn plant during late June and early July. And it seems that hot weather does not have nearly as much to do with hastening ripening as it does with causing rapid growth before tasseling.

Cold Nights

It is a common belief that corn will not grow satisfactorily in regions where the nights are cool, though the days be warm. Usually, the true explanation why corn is not grown in such sections is something else. In South Africa, where corn growing has expanded at a phenomenal rate since 1900, the minimum temperature at night during the tasseling season averages only about 60 degrees, and in some sections it is as low as 55 degreees Cool nights reduce the rapidity of growth previous to tasseling, but if the season is long there is no definite proof that cool nights (55 to 60 degrees at the low point of the night) reduce the yield.

Summary

The ideal corn season in the central part of the Corn Belt is about as follows:

May—65 degree mean temperature (warmer than average), 3.5 inches of rain.

June—71 degree mean temperature, 3.5 inches of rain.

July—73 degree mean temperature (cooler than average), 4.5 inches of rain.

August—73 degree mean temperature, 4.5 inches of rain.

No temperatures above 96 degrees in the heat of the day at tasseling time, ground thoroughly saturated with moisture during the twenty days following tasseling.

CHAPTER 4

THE ADAPTATION OF CORN

CORN, in its distribution over the United States, has been changed in many ways by nature and by the plant breeder and farmer. The corn crop has shown especial adaptability to differences in length of seasons. At the present time, there are at least 1,000 varieties, some of which mature in 80 days in the North and others in 150 days or more in the South. Because of its wonderful adaptation to conditions, the crop is now grown with success in every state of the nation, from sea level to plateaus a mile above.

Home-Grown Seed

Ordinarily, it is a poor practice to buy seed corn. The average farmer should rely chiefly on seed grown in his own field or his neighbor's field until he has proved by actual test in his own field that a certain strain from outside has greater yielding power. It is usually folly of the worst sort for a farmer in central Nebraska to buy any large quantity of Indiana seed corn, even though it may be grown in the same latitude. Moving corn more than 100 miles north or south is always uncertain. However, Reid Yellow Dent, as grown in south-central Iowa, usually gives a good account of itself in central Illinois, and vice versa. Some sorts do poorly when moved only twenty or thirty miles, whereas other strains have an unusually wide adaptation.

Farmers have observed the superiority of well-adapted varieties. This superiority is demonstrated when good home-grown seed is planted in comparison with seed imported from a distance. The value of home-grown seed was shown in two series of five-year tests conducted by the United States Department of Agriculture in co-operation with twenty-eight state experiment stations. Equivalent lots of seed were grown each year at all the stations. These experiments indicated that varieties which produce best at home often yield poorest when tested under another environment.

During a period of seven years, samples of seed corn obtained from forty to sixty farmers in each of twenty-nine counties in Iowa were planted side by side under identically the same conditions for a comparative study of quality and yielding power. These tests showed that in each of these counties there were from three to eight men who had corn yielding an average of 10.9 bushels per acre more than the average of all other local corns tested, an average of 19.7 bushels per acre more than seed purchased from seed firms, and an average of 13.5 bushels more than seed introduced into the county from prominent seed corn breeders or growers in other sections of the state.

At the Nebraska station, six leading varieties of corn were compared for two and three years, the seed in one case being native grown and in the other from Iowa or Illinois. Here in every case the native seed of the same variety gave the better yield, the average being a difference of 6.2 bushels.

Effect of Acclimatization on Yield*

A more striking result was secured when varieties representing three degrees of acclimatization were grown in comparison at the experiment station. The first group of five varieties represented seed taken from samples receiving high prizes at the National Corn Show. They came from the very best growers, and were undoubtedly productive varieties of corn in Illinois, Indiana and Ohio, where they originated. Being show corn, it is probable they had been grown under most favorable conditions, thus making them less suited than the average to withstand the very dry and unfavorable season they were grown at the station. The second group was made up of a collection of varieties secured from growers in the state, but located at some distance from the station and on somewhat different soil. The third group was made up of a collection of varieties grown for several years by farmers near the station.

Table I—Effect of Acclimatization on Corn

Character of Seed	Yield Per A.
Show corn from Illinois, Indiana and Ohio (five varieties)................	39.8 bushels
Seed from growers in state (five varieties)..	45.6 bushels
Local varieties near experiment station (seven varieties)..................	48.8 bushels

These results were unusually marked, due to the very dry, hot season during the earing time, but a season that would not be unusual farther west in the state. The data plainly indicate the value of native seed—that from a distance yielding 39.8 bushels; that from the state, but at some distance, yielding 45.6 bushels, and that from farmers near the station yielding 48.8 bushels per acre.

Changes in Corn Not Adapted†

When corn grown in one section of the country for a number of years is moved to another section where soil and climate are different, the plant always undergoes more or less change during the first two or three years before it becomes adapted to its new conditions.

The definite effect of climate in modifying the corn plant is shown in the following experiment: Seed of two varieties of corn, Snowflake White and Iowa Gold Mine, was obtained from Iowa and grown in

*Nebraska Bulletin No. 126.
†Nebraska Bulletin No. 91.

Nebraska for two years. In the third year, seed was taken from this, and seed was also obtained from the same original source in Iowa. These were all planted in adjacent plots at the experiment station. A marked difference was shown throughout the experiment between the different plots. In the Snowflake White variety, the stalk from the seed that had grown in central Nebraska for two years had decreased almost a foot in height, the ear was 8.8 inches lower down, and the ear shank almost two inches shorter, while the plants from Nebraska seed had an average of 1.2 fewer leaves.

The weight of both stalk and ear was found to be heavier in the corn grown from the seed just from Iowa, but the proportion of ear to stalk was higher in the acclimated corn. The Nebraska corn averaged almost 200 square inches less leaf area, which was to be expected of plants grown in a drier climate. The yield of grain was in favor of the home-grown seed.

Similar conclusions were indicated from variety tests. Of the twenty-two varieties that were tested by the co-operating farmers in various parts of the state, thirteen were Nebraska grown, four from Illinois, two from Iowa, one from Indiana and two from Minnesota. In these experiments, the significant fact was revealed that not one of the nine varieties the seed of which was grown outside of the state ever took first or even second place in the average results for the state. These results do not indicate that the varieties from the other states are poorer seed than our own. Their low yield is due to the fact that they are not at first adapted or acclimatized to our own conditions.

The lesson to be learned from this is that to get the best results in corn growing, the seed must be home-grown, and grown not only in the same state but in the same locality. The results of the variety tests indicate that seed grown in eastern Nebraska will not do as well in western Nebraska as local varieties, and vice versa. There should be careful growers of seed in every county of the state.

Use of Unadapted Seed

Too many will send away for seed when better seed may be found at home than can be obtained anywhere else. It is always uncertain to buy seed from a distance, and this is doubly true when good seed is scarce. One is likely to pay much more than it would cost to separate out the good ears by means of the germination test. Seed grown as far south as Oklahoma has been sold through agents to Corn Belt farmers for planting their crop. There can be but one result—soft corn.

A mistaken idea prevails in regard to the "running out" of corn because it has been grown too long in a locality. The longer a corn is grown in the same locality, the better adapted it becomes to the conditions of that particular locality, provided good seed is used each year.

On the edge of the Corn Belt and in new corn regions, much trouble is caused by growing unadapted strains. Nearly every introduction

of unadapted corn has proved to be a failure. A corn grower in southern New Mexico introduced practically every known variety of the Corn Belt, but with no success. The unselected native corn of his own section yielded more than fancy, high-priced, imported seed. Many other similar instances could be quoted.

If seed corn must be purchased, it should be obtained from a locality where soil and climatic conditions are practically identical with those of the place where the corn is to be grown. The price of seed corn is not important. The loss of from two to five dollars a bushel, the average price of seed corn, is small as compared to the loss of a large part of the crop. A bushel of seed corn should produce on the average 300 bushels of corn. At 50 cents a bushel, the produce of a bushel of seed is worth $150. The loss of stand, immaturity, etc., resulting from unadapted seed corn may actually cause a loss of $20 or $30 per bushel of seed planted.

CHAPTER 5

PICKING SEED CORN

IT IS doubtful whether the governor of each Corn Belt state could issue a more valuable proclamation each year than one proclaiming a suitable week for all farmers of the state to gather and dry seed corn. One year the governor of Iowa issued a proclamation as follows:

To The Farmers of Iowa:

Your attention is again directed to the serious situation that often confronts the state in the springtime on account of the lack of good seed corn. Because of the high valuation of our land, it is essential that the very best seed possible be provided.

Wages are high and hired help hard to secure. It is, therefore, primarily important that everything possible be done to increase the production of corn per man power. One hundred per cent seed corn will very greatly increase the production of corn per acre and the production per man power.

Permit me again to urge every farmer to save enough seed corn this fall to supply his needs for next season, and if possible, a surplus for the following season. By doing this, you are following a wise and sound business principle, as well as rendering a service to agriculture generally and our whole country.

Therefore, by virtue of authority in me vested, I, W. L. Harding, Governor of the State of Iowa, call upon all of the farmers of this state to help in this important work, and for the purpose of concentrating upon this matter, I proclaim and set aside the period commencing September 20 and ending October 2, 1920, as seed corn weeks, and earnestly urge that this period be made one of general participation in this great work.

In Testimony Whereof, I have hereunto set my hand and caused to be affixed the great seal of the state.

Done at Des Moines, this sixteenth day of August, 1920.

No prudent Corn Belt farmer will allow October 15 to pass without having sufficient seed for at least one year's planting stored where it can not be injured by unfavorable weather conditions. The average farmer who picks corn from his own field a week or two before killing frost, and who stores that seed in an airy place where the ears do not touch and where they will not freeze before they are dried out, will get paid, on the average, at least a dollar an hour for his time. In the northern part of the Corn Belt, October 1 should be the latest date for picking seed corn from the field. Field selected seed should be picked several weeks before the corn is dry enough to husk and crib.

Farmers in localities that sometimes have no seed corn because the previous season was too dry or too short may "insure" themselves by

saving early each fall a supply of seed corn sufficient for two or three years' planting. Good seed corn well eared for will retain good germination and high productivity for three years.

Corn has been transported from a land of perpetual summer, where the returning wet season permitted the seed to germinate without having

Picking seed corn before frost.

endured winter conditions. It has been introduced into northern localities where the winters are severe. It has shown a remarkable ability to adapt itself to short summers, but is dependent upon man to care for its seed during the winter. Therefore, seed corn should be picked before killing frost.

To get the largest yields of corn, it is desirable to grow a variety that will use nearly all of the growing season of an average year. In the seasons shorter than the average, much of the corn will not dry enough to escape injury from freezing. In such seasons, field selection is necessary to obtain seed that will grow. In some varieties, continued early selection will tend to reduce the number of days required for maturity by as much as a week or ten days. In the northern half of the Corn Belt, this earliness is desirable and will not reduce the yield if other factors are properly cared for.

In years when June, July and August are unusually cool and rainy, it is of altogether extraordinary importance to go through the field in

late September and pick one bushel of the best matured ears for each three acres which are to be planted the following spring. The frost damage to seed corn in 1915 and 1917 was forecast long in advance by the cool summer weather. On the other hand, in years of heat and drouth during July and August, there is almost never any danger of frost damage to seed corn unless there are exceptionally heavy rains in September and October. In such years it may be perfectly safe to delay the picking of the seed corn until regular corn husking time. To be on the safe side, however, it is well to make it an invariable rule to pick and hang up one week before the average date of killing frost one bushel of seed corn for each three acres to be planted the following spring.

Cause of Freezing Injury*

The underlying causes of freezing injury are late maturity of the corn and abnormally early freezing weather. Late maturity may result from (1) late planting, (2) planting of unadapted varieties, and (3) peculiar weather conditions which do not favor early ripening. Undue early freezing may work similar injury to corn which would possess strong vitality under normal weather conditions. When subjected to a severe frost, immature corn suffers a partial or total loss of germinative power.

The germ in a sound kernel of corn is an embryonic living plant with stalk, leaves and root. When this living germ contains a large amount of moisture, some physical or chemical change is brought about by freezing, which results in death. Following this, the germ usually turns dark in color, which is a fairly safe index as to whether the germination has been destroyed.

As the moisture content of the corn decreases, the injury to the vitality of the kernel from exposure to any given freezing temperature is decreased. Dry corn containing 10 to 14 per cent of moisture will not be injured by any amount of winter freezing. Air dry corn with a moisture content of 10 or 12 per cent will withstand the freezing temperature of liquid air, or 190 degrees Fahrenheit below zero. On the other hand, corn with 60 per cent moisture may be killed by prolonged exposure to barely freezing temperatures. There may be variation in the moisture content of kernels on the same ear, which will account for partially impaired germination of an ear. In 1915, as much as 16 per cent variation was found in the moisture content of such kernels.

*Nebraska Bulletin No. 163.

Table II—Moisture Content and Germination of Corn Harvested at Various Dates During Fall and Winter of 1917-1918

Condition of Corn at Time of First Frost, October 8	Moisture in Grain of Corn Gathered on				
	Oct. 8*	Nov. 19	Dec. 11	Dec. 29	Jan. 17
Shocked Corn—					
1. Fairly well matured, ears solid	30	17	15	16	14
Corn Standing in Field—					
2. Fairly well matured, ears solid	35	17	16	15	14
3. Somewhat rubbery, ears twisted	39	21	18	16	17
4. Very rubbery, grain medium soft	43	26	23	19	19
5. Grain very soft	47	27	26	21	22
6. Late dough stage	50	34	28	28	27
7. Milk stage	63	36	33	29	28

Condition of Corn at Time of First Frost, October 8	Per Cent Perfect Germination of Corn Gathered on				
	Oct. 8	Nov. 19	Dec. 11	Dec. 29	Jan. 17
Shocked Corn—					
1. Fairly well matured, ears solid	98	85	93	87	86
Corn Standing in Field—					
2. Fairly well matured, ears solid	98	83	87	93	88
3. Somewhat rubbery, ears twisted	94	56	79	59	61
4. Very rubbery, grain medium soft	92	34	20	14	20
5. Grain very soft	92	14	17	5	6
6. Late dough stage	82	10	10	0	0
7. Milk stage	44	1	1	0	0
Minimum temperature, degrees F	24	17	−16	−18	−21

*The first selection was made after the first killing frost, which occurred in the early morning of October 8.

November 19—Prolonged freezing, with minimum of 17 degrees F.
December 11—Prolonged freezing, with minimum of −16 degrees F.
December 29—Prolonged freezing, with minimum of −18 degrees F.
January 17—Prolonged freezing, with minimvm of −21 degrees F.

Methods of Selection

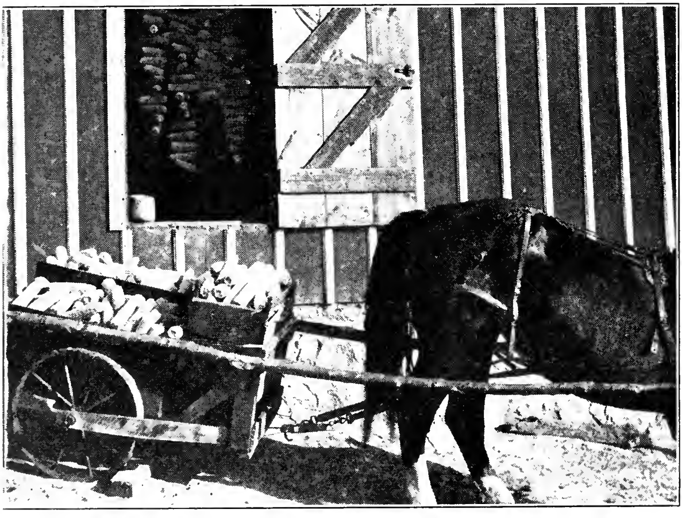
If the best seed ears are planted in one portion of the field, a large amount of labor will be saved in picking seed corn in the fall. This portion of the field will usually contain the number of good seed ears sought.

Seed corn should be:

1. Well adapted to seasonal and soil conditions where it is to be planted.
2. Grown on productive plants of a productive variety.
3. Well matured and preserved from ripening time until planting, so that it will retain its full vigor.

A seed corn cart is one of the most convenient aids in gathering seed corn. It calls attention to the necessity of getting into the field before the first frost, to select the seed ears. A wooden soap box fastened upon a pair of iron wheels similar to cultivator wheels, and a couple of poles for shafts makes a cheap but handy seed corn cart. A seed corn sack is not so inviting to the ordinary farmer. Anyone who has carried a sack containing about a bushel of corn through the field knows that it is a tiresome task.

More than one row of stalks may be observed when picking seed corn. However, as much time as possible should be given to a study of stalk conditions. The practical rule to follow in picking seed corn in the field is to save the ears which are medium large, well matured, solid, and carried on a stiff stalk at from three to five feet above the ground.



A seed corn cart.

The ear should be borne on a shank which points the ear downward rather than upward. Later on, the ears may be gone over for the finer points. Of course, no ear should be saved showing any sign of mold, and neither should an ear be saved if it comes from a stalk infested with smut, fusarium or any other kind of disease.

In Illinois and the states further west and north it seems to be advisable to pick for ears with a moderately smooth dent, ears with kernels which are smooth, shiny and horny. In central and southern Indiana, however, highest yields are obtained with roughly dented corn which

is somewhat starchy. A rather broad, thick kernel seems to be best in nearly all sections. The kernel should carry its width well toward the tip, for there is probably no more serious weakness in Corn Belt seed corn than the narrow, tapering, shoe-peg type of kernel. Ears carrying kernels of this sort almost never have that solid, heavy-for-their-size feeling which characterizes ears with broad, thick kernels which carry their width well toward the tip.

If home-grown seed is not selected before husking time, it may be obtained by any of the following methods:

1. Select from the load when husking for early feed.
2. Select at time of general husking by having a box on the side of the wagon for seed ears.
3. Select at the time the husked corn is being elevated into the cribs.
4. Select and test ears from the crib during winter or spring.
5. Use one-year-old seed.

The first method is practiced only to a limited extent, while the second method is the most common way of getting seed corn, and is a satisfactory method in years of well-matured corn. However, in "soft corn" years there will be great difficulty in getting viable seed. The third and fourth methods are better than using unadapted seed. If the one-year-old seed has been kept under good storage conditions, it makes desirable seed for planting.

CHAPTER 6

STORING SEED CORN

TOO often seed corn is not taken care of after picking. If field-selected seed corn is not stored in a dry, well-ventilated place where it will not freeze, it may as well be left in the field until harvest time. The husked ears should be stored the same day that they are picked. A good storage place for seed corn should have the following essentials:

1. Dry.
2. Well ventilated.
3. Protected from weather.
4. Temperature above freezing.
5. Free from mice.
6. Convenient for handling and testing the seed.

Provided the windows and doors are left open on all clear, bright days during the fall, the following are good:

1. Dry attic or spare room.
2. Dry cellar.
3. Any dry, well ventilated building.

All the following places have so often proved bad for seed that they should be avoided:

1. Barn where there is live stock or hay-mow above live stock.
2. Over oats or corn.
3. Damp cellar.
4. Closed attic over kitchen.
5. Any damp or closed place.
6. Out in the open.

The common practice of hanging seed ears in corn cribs or other open buildings may obtain good ventilation, but it offers no protection against freezing. Although corn containing less than 16 per cent of moisture is not readily injured by cold weather, most seed corn contains more than this amount of moisture in the fall. Under certain conditions seed corn may be stored in a dry basement. This practice should not be encouraged unless the ventilation is good. Frequently, the ventilation of a basement is poor and the humidity of the air high, affording good conditions for the growth of mold. There is probably no better place in which to store seed corn than in a well ventilated room in the house, provided the room temperature does not fall below 26 degrees F. A desirable arrangement for the farmer who saves a large amount of seed corn is to build a house especially for storing seed corn.

The method of storing is of secondary importance, provided the place is right. The method selected, however, should provide a free circulation of air on all sides of each ear. In other words, no two ears should touch, nor should they lie flat upon a board or other surface. This is especially important when the ears are selected early and contain a large amount of moisture. It is also important that the seed be

protected from mice and rats. A method which probably best meets both of these conditions is that of hanging the ears individually. It is safe to take down the ears when the moisture content is less than 18 per cent. Seed corn stored under good conditions should be dry enough to withstand winter temperatures within fifty days after picking.

Artificial heat is sometimes used in drying seed corn, where it is necessary to dry it rapidly or where large quantities are handled. When heat is used, it should be applied gradually and temperatures higher than 70 degrees should be avoided. Too rapid drying will injure the vitality of the seed. For small quantities, however, such as will be needed on individual farms, air drying of seed corn is satisfactory.

The twine hanger.

Wire Hanger

One of the cheapest, most convenient and most satisfactory hangers for storing seed corn is the wire hanger, cut from electric-welded hog-tight fencing. As the hangers are cut from the wire the long way, they may be made any desired length. This wire has perpendicular strands two inches apart and horizontal strands four inches apart, thus making a 2x4-inch rectangular mesh.

The wire is cut in such a manner that looking at the hanger filled with corn and hanging up, two ears are hung in pairs, opposite each other, and each pair of ears is four inches below the pair above. The wire may be cut with a cold chisel and a hammer, using a piece of iron on which to rest the wire; or with a pair of wire cutters.

Seed ears may be placed on these hangers rapidly. The hangers may be hung on nails driven into rafters or 2x4's, with the greatest economy of space. These hangers may also be carried from place to place and conveniently laid on tables for the germination test without having the corn fall off. When through with them in the spring, they may be tied in bunches and stored in a small space. The cost of wire and the labor in preparing hangers for 1,000 ears need not exceed two dollars.

The illustration shows 48-inch wire fencing cut for making seed corn hangers. It will be seen that the wire is cut in such a manner as to prevent waste.

Making seed corn hangers out of electric welded fence. Note the alternate wire method of cutting.

Binder Twine Hanger

The binder twine hanger is one on which a large amount of seed may be hung in a comparatively short time and in a little space. Take a piece of binding twine, twenty to twenty-five feet in length, and after tying the ends together, place a loop over each hand and lay an ear in the middle at the bottom so that each end of the ear is supported by a strand of the twine. The two ends of the loop are then crossed and another ear is placed on the crossed twine above the first one. This operation is repeated until the string is full. By the use of a shuttle device, one man can string the ears about as fast as two can working without it. Objections to this hanger are that ears fall out and one ear can not be removed without tearing down the entire hanger.

Other Hangers

Woven wire, tacked on both sides of a framework, made preferably of four-inch material, makes a handy seed corn rack. Lath tacked four inches apart on each side of four-inch uprights make desirable racks. Each pair of lath accommodates twenty-five or more ears. Such a rack five feet in height holds 400 ears.

Other good devices are made by driving nails into boards, poles, or posts, over which the butts of the ears are thrust. These hangers are known as seed corn trees. A large number of devices for storing corn have been offered on the market. Many of them give good satisfaction and may be used by those who do not care to devise a method of their own.

CHAPTER 7

TESTING AND GRADING SEED CORN

IF SEED corn is picked before freezing weather and stored in a dry, well ventilated place and protected from freezing temperatures until it is well dried, there is no need of seed corn testing. But in order to be absolutely safe, every farmer, in February, should germinate two hundred kernels of corn from two hundred ears taken at random. If less than 90 per cent of these kernels grow strongly, it will almost certainly pay the farmer a dollar an hour for his time to make a thorough ear by ear test of all the ears which he expects to plant.

The Cheap and Efficient Rag Doll

The rag doll seed corn germinator, according to Hughes, of Iowa, made possible a satisfactory corn crop throughout all of the Corn Belt in 1918, when we were at war and when a failure in our corn crop would have been a national disaster. Seed corn fit to plant was not

Rag doll (courtesy of Iowa Station)

to be had in any quantity, perhaps not enough to plant one-tenth of the corn crop. The only means of getting good seed was by testing millions of individual ears, separating the good from the bad. The doll germinator was used in making practically all of these tests.

The ear by ear test may be made easily with the rag doll tester, which is the simplest of all the home-made testers. To make and fill a forty ear rag doll tester:

1. Tear sheeting into strips nine inches wide and seventy inches long.

2. Spread the cloth lengthwise on table and rule through the middle and crosswise every three inches, leaving five inches on each end. This makes twenty squares on each half of the doll.

3. Number the squares, beginning with "1" in upper left-hand corner, "20" in upper right-hand corner, "21" in lower left-hand corner, "40" in lower right-hand corner.

4. Write numbers corresponding to the forty ears being tested on the back of the left-hand end of the cloth.

5. Thoroughly wet the cloth and spread it smoothly on the table, with Square No. 1 at the left.

6. Remove six kernels from representative parts of Ear No. 1 and place in Section No. 1 of the cloth, etc.

7. Use a stick or roll of paper the diameter of a pencil, around which to roll the cloth.

8. Roll the cloth carefully, but not too tightly, beginning at the right-hand end.

9. Place a cord or rubber band loosely around the middle and firmly around each end of the rag doll.

10. Soak in lukewarm water for five to ten minutes.

After soaking, turn a bucket upside down over the dolls, keeping them from drying out while the kernels are given time to germinate. If placed in a pail, the dolls should be raised so that the lower end will receive sufficient air and not stand in the water. If the dolls are stood up, the sprouts will grow toward one end and the roots toward the other, making the test much easier to read than where the dolls are allowed to lie flat. This method also insures better drainage and better ventilation. It is also well to put a wet piece of gunny sack or other coarse cloth around the dolls to prevent them from drying out. The dolls should be sprinkled often enough to keep them moist. They should be kept at room temperature, 60 to 80 degrees F. The end bands should be removed after two days, to allow sufficient room for growth. In five or six days, the germination test should be ready to read.

To read the test, carefully unroll the doll. Examine all kernels closely. In case all six kernels do not show strong germination, the ear should be discarded. There is danger of discarding as worthless, however, ears called "slow germinators," which, though backward in germination, are practically as strong as any. At the Iowa station, ears which when tested and read as having six weak kernels, gave a higher stand and a greater yield in tests than any other class of ears with the exception of those read as six strong. If seed is very scarce, it may be well to save ears showing not more than one dead kernel out of the six tested. In reading the test, watch for signs of mold and other disease. The use of the germination test in selection of disease-free corn will be gone into more in detail in Chapter 25.

Cost of Testing

The cost of testing individual ears of corn for germination depends upon the method used and the efficiency of the operator. From the tests made at the Iowa experiment station, the cost has been found to be from 15 cents to 45 cents for each one hundred ears. The difference was due entirely to the method of testing which was employed. The cost of testing corn by the rag doll method was 18 cents and by the sawdust box method, 27 cents. This was on the basis of pre-war values.

The cost of selecting seed for planting an acre will depend upon the method used and the quality of the corn. If the corn is of fair quality so that it is not necessary to throw away too many ears, the cost per acre will be less than 10 cents. And even if the corn is of such poor vitality as to make it necessary to throw away 85 per cent of the ears, the total cost of getting out enough for an acre will not be over 25 cents.

What to Do if Low Testing Corn Must Be Planted

Even though corn with a general test as low as 60 per cent must be planted, the effect on the yield is not necessarily very serious, provided the farmer knows that he is planting low testing corn and increases his rate of planting accordingly. If the farmer would plant 100 per cent corn at the rate of three kernels per hill, he should plant 60 per cent corn at the rate of five kernels per hill in order to get as many live kernels planted on each acre as with good corn. According to the theory of probabilities, 17,500 kernels of 60 per cent corn planted on an acre of 3,500 hills would result approximately in:

36 hills with 5 dead kernels.
272 hills with 5 live kernels.
907 hills with 1 dead and 4 live kernels.
269 hills with 4 dead and 1 live kernel.
1,210 hills with 2 dead and 3 live kernels.
806 hills with 3 dead and 2 live kernels.

If the live kernels from 60 per cent corn grew as vigorously as from 100 per cent corn, the yield should not be affected by more than two or three bushels per acre by such a distribution as the above. At any rate at the Nebraska station, as a five-year average, they found that alternating hills of one, two, three, four and five plants yielded at the rate of 58.6 bushels per acre, as compared with 59 bushels where every hill contained three plants. One of the greatest objections to planting 60 per cent seed corn is that the hills with four to five stalks have a rather high percentage of nubbins.

Shelling and Grading Seed Corn

Shell the seed corn by hand, discarding the tips and butts. Shell each ear in a pan by itself before dumping it into the sack with the rest of the shelled ears. As you shell, note the kernel type. Throw out ears the kernels of which show decided signs of starchiness or dull color on the backs of the kernels; also throw out ears with kernels showing blis-

tered germs or other signs of immaturity. Watch for moldiness around the tips of the kernels. Moldiness is one of the most serious seed corn defects, and all ears showing a sign of it should be thrown out. Discard ears with shoe-peggy kernels which do not come out full and plump to the tip. Moderately large, well-matured kernels, with a plump tip and with a shiny, horny back, free from starch, seem to be associated with yielding power more than any other factors which we can tell about merely by looking at the seed. Shelling corn by hand gives the time required to judge the kernel type effectively. It also avoids a few broken kernels, although this is really not important.

After shelling, it helps a little to run the corn over either a cheap hand grader or a cylinder machine grader. Iowa experiments indicate that size of kernel is one of the most important things in determining yield. The light, small kernels are especially likely to be poor yielders. Theoretically, therefore, the eliminating of the small kernels with a grader should be decidedly worth while. And, of course, kernel uniformity is of real help in getting the best results out of the corn planter.

CHAPTER 8

THE RELATION OF SOILS TO CORN

THE best corn soils are well drained, deep, dark loams. Sandy soils, unless heavily manured, are not desirable for corn, as they dry out quickly and are usually low in fertility. On the other hand, clay soils are, as a rule, poorly drained and too compact to produce the best corn.

The good corn soils of central Illinois and northern Iowa contain in the plowed soil of an acre about 1,200 pounds of phosphorus, 4,500 pounds of nitrogen, and 35,000 pounds of potassium. On this type of soil, one to two per cent of the nitrogen and one-half to one per cent of the phosphorus seem to become available in the ordinary year. A forty-bushel corn crop (grain and stover) removes from the soil sixty pounds of nitrogen, eight pounds of phosphorus and twenty-eight pounds of potassium. Nitrogen and phosphorus are the two elements that are likely to limit corn yield, except on deep peats where potassium is usually lacking. Calcium, applied in the form of lime, often gives an increase of three or four bushels of corn per acre.

Corn is the rankest feeding and the most destructive of soil fertility of all our common crops. Only on the very richest soils can corn be grown for more than two years in succession with any assurance of profit. In humid regions, corn yields may be maintained or increased by the use of (1) rotations, (2) barnyard manure, (3) clover, (4) crop residues, (5) good tillage, (6) commercial fertilizers.

Crop Rotations

The all-important and economical way of maintaining corn yields is to use proper crop rotations. Of course, the short-time tenant can not make very much use of the rotation. In other cases, rotation is very valuable, and should be an important part of the fertility plan of a farm. The most common rotations in the Corn Belt (in some sections wheat is grown instead of oats) are as follows:

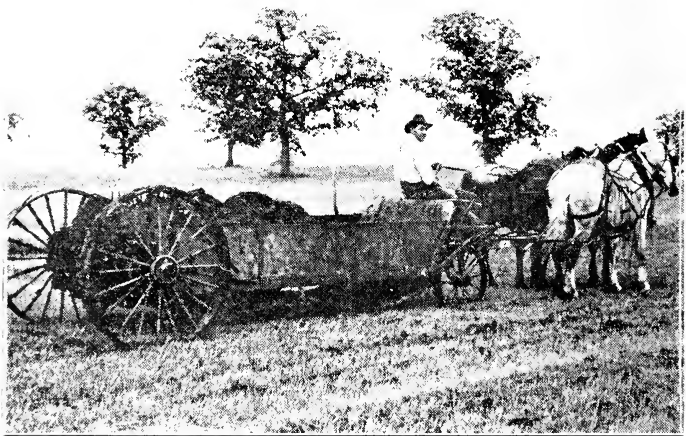
1. Continuous corn.
2. Corn-oats.
3. Corn-oats-clover.
4. Corn-corn-oats-clover.

When corn is grown on good land continuously, the available fertility not only decreases rapidly, but there tends to be increasing damage from corn insects and diseases. After ten or fifteen years of continuous corn growing, the yield tends to be about twenty-five bushels per acre, as contrasted with thirty-five bushels where the corn and oats

are rotated, and sixty-five bushels where there is a rotation of corn, corn, oats and clover, and where eight tons of manure are applied once every four years.

The corn, oats, clover rotation is preferred to the corn, corn, oats, clover rotation on the poorer soils and will give an increase of about five bushels of corn to the acre.

The typical, good corn soil of Iowa and central Illinois yields about fifty-five bushels of corn, one year with another, when a rotation of corn, corn, oats and clover is used and when eight tons of manure are



Spreading manure is one of the most important jobs connected with corn growing.

applied per acre every eight or nine years. If no manure whatever is used, and reliance is placed solely on a rotation of corn, corn, oats and clover for maintaining yields, the average acre corn yield one year with another on typical good corn soil should be around forty-five bushels, with the tendency very slightly downward as the lime leaches out of the soil and it becomes more difficult to get a stand of clover every four years. If a rotation of corn and oats alone is used without any clover, the yield should be around thirty-five bushels per acre, but with the tendency gradually downward. For ten or fifteen years there may be an average of only five or six bushels difference between the acre yield of a corn and oats rotation and that of a corn, corn, oats and clover rotation, but as the years go on, the difference seems to widen out to about fifteen bushels per acre.

Barnyard Manure

If the labor spent on the corn crop is to bring in more than hired-hand wages, the yield should be more than forty bushels per acre. But as to just what is the most practical plan of building up a corn soil beyond this point depends on the particular situation of each farmer. The man who has possession of a farm for only two or three years may find it decidedly inadvisable to make any effort to grow clover. But no matter how a man is situated, it almost invariably pays to haul out all manure every spring and every fall (oftener if it is at all convenient) and spread it at the rate of about eight tons per acre on land which is to be plowed for corn. If only enough manure were available, the problem of maintaining a highly productive corn soil would be very simple. Unfortunately, on most corn belt farms, there is available enough manure to give an application of eight tons per acre only once in every eight years. Under practical conditions, the fields near the barn get eight tons per acre once every four years, and the outlying fields get manure rarely if ever.

A ton of manure contains about ten pounds of nitrogen, two pounds of phosphorus and ten pounds of potassium, and it normally has the ability of eventually increasing the corn yield by about three bushels, as well as having some effect on the small grain and clover. The first step in building up a corn soil is to haul out the manure. The man who does not do that is rarely justified in spending money for lime, phosphate or other fertilizer.

Clover

Where a man has possession of a farm for a number of years, the third step in building up a highly productive corn soil is to grow clover once in every four years, instead of only once in every fifteen or twenty years, as is the case on most Corn Belt farms. But in order to grow clover successfully, it is necessary in many sections to apply two tons of limestone and 300 pounds of acid phosphate (or 1,000 pounds of rock phosphate) per acre once every four years. The limestone is best applied just previous to clover seeding, but the acid phosphate or rock phosphate is best mixed with the manure as it is loaded just previous to being hauled out to the corn ground.

Plow Under Corn Stalks*

Corn stalks should be turned under, and not burned. Probably no form of organic matter acts more beneficially in producing good tilth than corn stalks. It is true, they decay rather slowly, but it is also true that their durability in the soil is exactly what is needed in the production of good tilth. Furthermore, the nitrogen in a ton of corn stalks is one and one-half times that of a ton of manure, and a ton of dry

*Illinois Soil Report No 24.

corn stalks incorporated in the soil will ultimately furnish as much humus as four tons of average farm manure. When burned, however, both the humus-making material and the nitrogen are lost to the soil.

Proper Handling*

It is a common practice in the Corn Belt to pasture the corn stalks during the winter, and often rather late in the spring after the frost is out of the ground. This tramping by stock sometimes puts the soil in bad condition for working. It becomes partially puddled and will be cloddy as a result. If tramped too long in the spring, the natural agencies of freezing and thawing and wetting and drying, with the aid of ordinary tillage, fail to produce good tilth before the crop is planted. Whether the crop is corn or oats, it necessarily suffers, and if the season is dry, much damage may be done. If the field is put in corn, a poor stand is likely to result, and if put in oats the soil is so compact as to be unfavorable for their growth. Sometimes the soil is worked when too wet. This also produces a partial puddling, which is unfavorable to physical, chemical and biological processes. The bad effect will be greater if cropping has reduced the organic matter below the amount necessary to maintain good tilth.

Commercial Fertilizers

Having made the best utilization possible of rotations, manure, legumes and crop residues, the question arises whether mineral plant foods can be used profitably. It is well known that even live stock farming, with the most careful conservation of manure, does not maintain fertility (unless concentrates bought from outside the farm are fed). One of the most effective methods of increasing the value of manure is reinforcement with phosphorus. The use of 320 pounds of acid phosphate with eight tons of manure, at the Ohio experiment station has increased the yields of corn 6.2 bushels; of wheat, 3.3 bushels, and of clover hay, 413 pounds.

The effects of fertilizer are not always confined to an increase in yield. Quality, maturity and composition are other important effects, concerning which, however, little is known under Corn Belt conditions. The physiological effects of small amounts of plant food, applied at various times in the growth of the plant, have yet to be studied. The effects of nitrogen, phosphorus and potassium are not so simple as are commonly supposed. At the Wisconsin station, small amounts of fertilizers applied in the hill for corn have given better results than larger amounts broadcast. The use of fertilizer in the hill is also thought to increase the salt concentration of the corn sap sufficiently to enable it to withstand a lower temperature than unfertilized corn. One hundred pounds of acid phosphate per acre in the hill at time of planting the corn has given good results in Missouri.

*Illinois Soil Report No. 24.

The following is an outline of what seems at present to be the most logical program for soil improvement involving the use of fertilizing materials and with particular reference to the corn crop:

1. The growing of legumes at least once in a four or five-year rotation, preceded, when necessary, by liming, for supplying the bulk of the nitrogen and for liberating from the soil some of the potassium required.

2. The conservation of manure, and application on the ground preceding corn.

3. The use of small amounts of fertilizer used in the most efficient manner (probably in the hill at planting time), for the physiological effects on growth.

4. The use of larger amounts of fertilizer on the small grain crops of the rotation as a basic treatment in the maintenance of fertility, and for the residual effect on legumes.

CHAPTER 9

PREPARATION OF THE SEED BED

A FIRM seed bed with a mellow surface and all trash cut up finely and covered should be the aim of every grower in the preparation of a seed bed for corn. There is no danger of doing too much work. During the preparation of the seed bed, weeds can be killed more easily and cheaply than later in the season by cultivation.

Corn is planted on ground that has been in corn, small grain or sod the previous year. In the corn belt, it is estimated that about 35 per cent of the corn is planted on corn stalk ground, 45 per cent on small grain stubble and 20 per cent on sod ground. Therefore, three different general methods of seed bed preparation are necessary.

Preparing Corn Stalk Ground

On corn stalk ground, it is the general custom to break the stalks as early in the spring as possible with a railroad iron, harrow or heavy plank. The stalks are cut by disking with a well sharpened disk or

Disking the corn stalks.

stalk cutter. The ground is usually disked once to cut up trash, pulverize the soil, level the ground, and kill the weeds.

The practice of burning corn stalks is not so common as formerly. Agitation against this method, the lowering of the fertility in many fields because of continual cropping and the realization of the value of crop residues turned under have reduced the practice to a minimum. When corn stalks are burned, there is a loss of organic matter not only in the stalks but also in the soil. There are cases of rank stalk growth that justify burning the stalks.

Next, the ground should be plowed as early as possible in the spring, and shallow—four to five inches. Rarely in the Corn Belt is the corn husked early enough to allow fall plowing. Corn stubble, corn cut for fodder or silage, may be either fall or spring plowed. Spring plowing is best done early and shallow, in order:

1. To give trash time to decay.
2. To give the seed bed a chance to settle.
3. To give weeds time to start so that they may be killed before planting.
4. To prevent loss of moisture before planting.
5. To give thorough preparation of the ground.

Each half day's plowing should be harrowed in the direction of the plowing with a spike-tooth harrow, (1) to prevent the formation of clods and loss of moisture by evaporation, and (2) to level the surface and make disking easier. Final preparation of seed bed should be done just before planting.

Ordinary five-inch plowing seems to be satisfactory in the Corn Belt. It is always advisable, however, to do as thorough a job of plowing as possible. The following points should be kept in mind:

1. The furrows should be straight as possible.
2. A roundish furrow top with no breaks or depressions is desirable.
3. All trash should be deeply covered.
4. The furrows should be of the same width.
5. A uniform depth of furrow is desirable.
6. The plows should be in and out evenly at the ends.
7. The back furrow should be raised slightly and all trash covered.

Before planting, the seed bed should be disked and harrowed thoroughly for the following reasons:

1. To kill weeds.
2. To settle the seed bed.
3. To pulverize the soil.
4. To level the seed bed.

If disked but once, the land should be disked across the plowing. Harrowing should be done diagonally to or across the disking.

Preparing Small Grain Stubble

Small grain stubble may be plowed in either the fall or spring. Disking before plowing is a good practice. In the Corn Belt, there is more time to fall plow. The most important advantage of fall plowing is that it puts the farmer in control of his spring work, aiding him espe-

cially in getting his corn planted without delay. Those who have large areas to plow in the spring for corn usually are late with corn planting. Moreover, a few insects and their eggs are destroyed by disturbing them late in the fall. Other than these two, there are no advantages of fall plowing over spring plowing.

Good plowing.

Fall plowing of stubble ground should be done to a depth not to exceed six inches. It should be disked early in the spring, to hold moisture and to start weeds. Before planting, the field should be disked and harrowed enough to give a level, fine, well-firmed seed bed. Rolling with a corrugated roller is desirable on light types of soil. Spring plowing of stubble ground should be done early and shallow, not more than four inches deep. Harrow immediately, and disk and harrow to put the ground in shape.

Preparing Sod Ground

There are more advantages in plowing clover, timothy or blue grass sod for corn in the fall than stubble ground. Sweet clover sod after one year's growth is an exception. It should be spring plowed in order to keep down volunteer growth. It is advisable to plow other sods late in the fall to allow for a maximum growth of pasture or green manure. Fall plowed sod is far easier to work than spring plowed sod. Fall plowing of sod reduces the damage done to corn by drouth the following season.

In addition, late fall plowing will destroy many cut-worms, wire-worms and other insects which are more noticeable after sod. Blue grass sod should be plowed shallow, and clover sod deep, because of the difference in rate of decay. It is best to allow the fall-plowed ground to lie rough over the winter, but it must be worked down early in the spring and otherwise carefully managed. If spring plowed, sod ground should be disked first, plowed early and shallow, and then disked and harrowed thoroughly. After spring plowing of sod ground, double disking with

Harrow each half day's plowing.

cross disking is necessary. The amount of work required to put the ground in good shape for corn will depend on the condition of the sod and the time of breaking.

Wild grass sod is harder to work than clover and timothy sod, and is much slower to decay. This kind of sod should be plowed in the early summer, if possible. Deep breaking, four to six inches, should be done, and the furrow slice should be turned over flat. Shallow, plowing, two to four inches, followed by "backsetting" (second plowing) about two inches deeper, after the sod has rotted, is a desirable method for tough sod. In either case, the ground should be thoroughly packed and disked to put the seed bed in good condition for corn.

Standard Day's Work

The amount of work done in a ten-hour day on average Corn Belt farms (based on 1922 Yearbook, United States Department of Agriculture) is as follows:

Plowing with horses:

	Acres.
Walking, 14-inch, one man, two horses	1.9
Sulky, 14-inch, one man, four horses	2.6
Gang, 24-inch one man, four horses	4.1
Gang, 24-inch, one man, six horses	4.9

Plowing with tractor:

Two-plow	6.7
Three-plow	8.2
Four-plow	10.4

Harrowing with horses:

Sixteen-foot spike-tooth, one man, four horses	38.7

Disking with horses:

Eight-foot single disk, well-packed land, one man, four horses	17.1
Eight-foot single disk, freshly plowed land, one man, four horses	15.2

CHAPTER 10

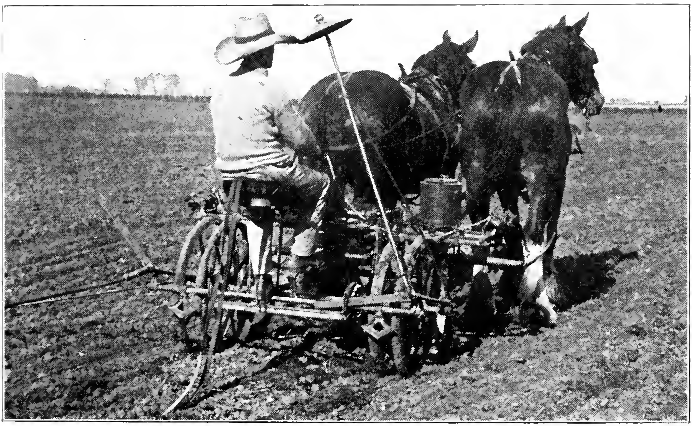
PLANTING CORN

THERE are three general methods of planting corn: (1) surface planting, (2) listing, (3) furrow opening.

Because of the weed factor, a large percentage of the corn in the Corn Belt is surface checked on a well-prepared seed bed by the use of the two-row corn planter. Surface planted corn is usually checked—planted in hills, to permit cross cultivation. The check is made by a knotted wire which regulates the drop of the seed.

Types of Check-Row Planters

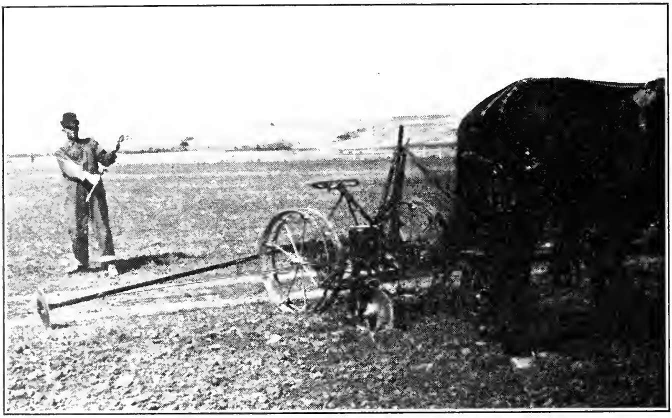
The planters that are used may be divided into three classes, according to the type of planter plate, as follows: (1) edge drop cumulative, (2) flat drop cumulative, (3) full hill drop. Corn planter tests by C. O. Reed, at the Illinois station, indicate that deep, rather narrow kernels of the Reid type, when well sorted with a grader, were planted with equal accuracy by both edge and flat drop types of planter plates. Tests with other varieties showed an advantage for the flat drop over the edge drop. In every case, the full hill drop proved to be 20 to



Corn planting. The horses have just been turned around at the end of the row, and the marker has not yet been dropped.

30 per cent less accurate than the other two types. The full hill drop had a tendency to plant about 15 per cent of the hills with four kernels and a few hills with five kernels, when three were desired.

The planter should be tested as to its regularity in dropping the desired number of kernels. This testing may be done on a clean, hard surface by tripping the planter by hand. Planters are provided with a series of plates made to drop different numbers of kernels of a given size. The process of selecting the plate that will drop the desired number of kernels in each hill is called calibration. It is desirable to have a planter drop the required number of kernels in at least ninety out of



Moving and stretching planter wire before starting a new row.

one hundred hills. If the planter fails to drop the kernels correctly, the plates should be changed or filed until they will drop the required number. The plate adjusted to each lot of corn should be put with that lot, to avoid any confusion at planting time. Place the seed in gunny sacks. Put less than two-thirds of a bushel in a sack, and hang it in a dry place until ready to plant.

Method of Checking Surface Planted Corn

It is not difficult to get checked corn straight both ways in a field that is not irregular in shape or hilly. A first-class job of checking corn consists in planting the rows absolutely straight both ways. It requires an energetic team, well matched as to disposition and rate of walking, and a driver who understands how to drive and to set a check wire. To make the rows straight in either direction, it is necessary to start right and keep right. The rows should be planted the long way of the field, and work should commence on a straight side.

The end of the reeled wire must be fastened to the iron stake and the latter fastened in the corner of the field where the work is to be commenced. The planter, carrying the spool of wire, is driven to the other side or end of the field, unreeling the wire. After laying the wire across the field, it should be stretched reasonably tight and fastened at the end of the field. Here, it is connected with the planter, and two rows are planted with one trip across the field. At the end of the field, the wire is released and the planter turned around. At this end of the field, the wire is moved over twice the distance between rows. The wire should be stretched to the same tension every time it is set and then connected with the planter. This process is repeated until the field is planted and the wire wound on the reel.

In an irregular shaped field, where the rows lengthen or shorten, as the work progresses, it is best to set stakes at the irregular end, setting one every forty feet, at a point touched by a button on the wire, the series of stakes representing a cross row. In this way, the operator may keep all the cross rows straight, setting his wire so that a certain marked button is constantly in direct line with the row of stakes. In case of surface irregularities, such as ridges or depressions, it is almost impossible to make the rows perfectly straight.

Small fields may be planted with hand planters, called "jobbers." These devices are used on spring plowed native sod ground, stumpy or stony fields, and test plots. They do satisfactory work and their use insures uniform dropping and covering. The field is marked off both ways with a marker and the kernels are dropped at the intersections. With a three-row sled marker, thirty to forty acres may be marked both ways in a day.

Surface Planting—Drilled

The other common way of putting in surface planted corn is drilling. Drilled corn is planted in rows that can be cultivated only one way. Experiments indicate that there is no appreciable difference between the average yields of drilled corn and that planted in checks where the same number of kernels are planted per acre and the corn is kept free of weeds. One kernel dropped every fourteen inches in the row is the drilled corn equivalent to three kernels per hill in corn checked three feet six inches. Drilled corn can not be cross-cultivated except when young, and then only with the harrow or weeder. On newly-broken sod, drilled corn may be kept fairly clean, but in the case of most Corn Belt land, drilled corn becomes very weedy. The ordinary corn planter is commonly used for drilling, but the grain drill with certain spouts stopped is extensively used on the western edge of the Corn Belt.

It is advantageous to drill corn under the following conditions:

1. When the field is hilly, because drilling with the rows at right-angles to the slope of the hill will keep down soil erosion.
2. When planting on sod ground, because it is usually free of weeds.
3. When planting corn for fodder or silage on clean ground, because drilled corn cuts more easily.

Listing

Listing is practiced in western Kansas, in western Nebraska, and in parts of northwestern Missouri and western Iowa. Listing is based on the principle given in the paragraph on depth of planting, on page 50. It is a common method in dry, windy, and light soil areas. It is not a general practice and is an undesirable practice on shallow soils and poorly drained ones. Listed corn has the following advantages over surface planted corn:

1. It withstands drouth better.
2. It is not so easily blown down.
3. It is a cheaper method of planting.
4. It is a quicker method, because it combines plowing and planting in one operation.
5. It gives higher yields under some conditions.

Listing is the process of throwing open a series of furrows across a field by means of a specially devised plow provided with a double mold-board that throws the soil both ways. The furrows are opened to a depth of six or seven inches, and are spaced the usual width of the corn rows. The corn is planted in the bottom of these furrows. Most listers have a drill attachment so that the corn may be planted as the field is plowed by the lister. Listed corn is rarely checked. There are two ways of listing—single and double.

The most common method is single listing. The ground is untouched during the winter and until planting time. Then the ground should be disked once or twice to kill weeds, but often the lister is the only implement used in preparation of the seed bed. It covers the entire surface between the rows with loose dirt, but underneath this covering of loose earth is a ridge of hard, unbroken soil. Such a preparation does not present the most favorable condition However, it is a rapid and cheap method of planting, as the one operation prepares the ground and plants the seed. Most listed corn is planted in this way.

Double listing is a slight modification of the above method. The only difference from single listing is that the ground is listed twice. The ridges which are left by the first operation are opened and thrown into the furrows by the second. This tillage completely loosens the surface soil and leaves it in much better condition than does single listing. In many cases the first listing is done in the fall and the field is allowed to remain in that condition until spring, at which time the ridges are opened with the lister. The second listing and the planting may be done at the same time.

Furrow Opening

A furrow opener consists of a pair of disks or shovels so arranged as to open a small furrow. One set of these disks or shovels is fastened to each planter shoe of an ordinary corn planter. They are set deep or shallow by regulating the lever on the planter. This method of

planting possesses practically all the advantages obtained by listing because the seed is planted in a furrow similar to listed corn. In order to use this attachment on the planter successfully, the ground must be prepared as for surface planted corn. This method is used extensively in the listed corn areas.

Table III—Yield of Corn as Determined by the Method of Preparing the Seed Bed, (Maryville, Nodaway County) Missouri—1911 to 1922, Inclusive

Method of Preparing Seed Bed	Yield in Bushels Per Acre									Nine-year aver., bushels per acre	Av. increase over surface planting
	1911	1912	1913	1914	1915	1916	1917	1919	1920		
Ground plowed, crop surface planted	49.9	62.8	14.5	44.9	41.1	46.3	75.0	78.5	51.7	51.6	
Ground plowed, crop planted in shallow furrows	55.6	76.5	18.6	51.4	53.0	60.9	81.9	78.4	55.2	59.0	7.4
Double listed	56.9	73.0	18.2	54.6	44.3	53.8	68.4	84.4	54.7	57.6	6.0
Double disked, single listed	67.4	75.5	36.7	54.1	42.5	56.7	80.2	75.2	53.2	60.2	8.6
No disking, single listed	60.3	80.0	43.1	58.1	45.2	59.2	84.2	91.9	55.9	64.2	12.6
Average	58.0	73.5	28.2	52.6	45.2	55.3	77.9	81.7	54.1	58.5	
Inches of rainfall for the months of June, July and August	5.71	6.30	8.78	6.28	31.1	10.8	10.7	8.78	5.28		

Rate of Planting

Thickness of planting depends on variety, soil, latitude and purpose for which grown. Also it should be kept in mind that in the central Corn Belt only 70 per cent of the kernels planted produce stalks. Most growers in the Corn Belt plan to get about three kernels in the hill, the rows being three feet six inches apart both ways. This distance between rows is more or less standard for planters, check wires and cultivators. In drilled corn, the distance between the rows is the same as in checked corn, and the plants should average ten to fourteen inches apart in the row.

On rich clover land or sod, with corn planted for fodder or silage, or with small varieties, checking at the rate of five kernels to the hill and drilling at the rate of one kernel every eight or nine inches often gives the best yields. However, even on rich land, corn planted at the rate of three kernels per hill produces ears which average about 50 per cent heavier than the ears produced when five kernels per hill are planted. Unless machine huskers are used, the labor of husking is so increased by thick planting that it is doubtful if five-kernel planting is warranted on even the richest soils of the northern part of the Corn Belt. On poor land, with tall growing varieties, two or three kernels per hill unquestionably give the best results. Planting for silage is discussed in Chapter 15.

Table IV

Following are the results obtained on soils much richer than the average with different rates of planting in different sections of Iowa for an average of 1920, 1921 and 1922:

No. kernels planted	Average Number Stalks at Harvest	Bushels Per Acre
NORTHERN SECTION		
2	1.78	53.39
3	2.60	66.50
4	3.16	71.77
5	3.89	74.56
NORTH-CENTRAL SECTION		
2	1.74	53.49
3	2.51	65.73
4	3.14	67.78
5	3.86	68.89
SOUTH-CENTRAL SECTION		
2	1.64	58.53
3	2.34	70.42
4	3.04	74.07
5	3.65	74.66
SOUTHERN SECTION		
2	1.76	49.49
3	2.35	60.75
4	2.35	60.75
5	3.68	59.18

A bushel of 56 pounds of seed will plant about seven acres where hills of three kernels are three feet six inches apart both ways.

Depth of Planting

No matter how deep the kernels are planted, they will send out their permanent roots an inch or two beneath the surface. In listed corn, the permanent roots are covered to a depth of five or six inches after their position has been definitely determined by the emergence of the young corn plant above ground. Of course, other permanent roots will also come out from the higher nodes which are surrounded by soil as a result of lister cultivation. In reality, surface planted corn sends out its permanent roots (not brace roots) from its bottom two or three nodes, which are located just beneath the surface of the ground, whereas, listed corn has the advantage of more nodes below ground and a larger, deeper root system.

The kernel should be planted only deep enough to be well surrounded with moist soil, usually not deeper than two inches. Corn planted too deeply will rot in the soil or the great effort of the seedling to emerge will stunt the growth. Where the seed bed has been thoroughly worked uniformity of depth of planting is obtained. If it is necessary to plant deeply because of dry weather, light soil or wind, it is advisable to use the lister or furrow opener planter.

Time of Planting

Corn planting usually begins when the normal mean temperature reaches 56 degrees F., and the bulk of the planting is done when the normal mean temperature reaches 61 degrees F.—about the middle of May in the central Corn Belt. Earlier planting is more difficult to keep clean, and often causes a loss of stand due partly to insects, but chiefly to rotting of the seed and increased susceptibility to disease. Later planting reduces yields and gives more opportunity for frost injury in the fall. Whatever the time of planting, the seed bed should be well prepared and danger of severe spring frosts should be over, although light spring frosts do not injure the young seedlings, especially under dry conditions. In fact, while a severe freeze will destroy that part of the young seedling which is above ground, it is astonishing how often a new vigorous growth is sent up from the roots. The practical optimum date of planting corn in the central Corn Belt, one year with another, is May 15. Planting before May 1 or after May 25 usually gives reduced yields.

Replanting Corn

Loss of stand is usually due to (1) bad weather conditions, such as frost or heavy rains; (2) poor seed; (3) birds, insects or rodents; (4) poor preparation of the seed bed; (5) planting too deeply, or (6) planting too early. Every precaution should be made to overcome these conditions. If, nevertheless, there is less than a three-fourths stand, the entire field should be replanted. A few missing or one-stalk hills may be planted by hand with the same or an earlier variety, but this is not so very practical. If the loss of stand occurs too late for replanting, it is best to disk the field or any poor part of it and sow to an emergency hay crop, such as Sudan grass or sorghum cane.

Acres Planted Per Day

According to the United States Department of Agriculture Yearbook for 1922, the standard number of acres planted in a ten-hour day is about as follows:

Two-row planter, 3½-foot rows, one man, two horses	14.0
By hand, 3½-foot rows, one man	4.5

CHAPTER 11

CULTIVATING CORN

THE average Corn Belt farmer with fifty acres of corn spends 300 hours of man labor and 600 hours of horse labor cultivating corn. At the same time, his team walks about 470 miles. This takes more time than any other farm operation except corn husking. Moreover, corn cultivation conflicts to some extent with haying and oat harvest. The principle of cultivation followed by most farmers is to cultivate the crop as many times as possible before the corn gets too high to work in. But they should keep in mind the reasons for cultivating and the cheapest, easiest ways of accomplishing the desired results.

Chief Reasons for Cultivating

A large number of corn cultivation experiments have been conducted throughout corn producing states. With but few exceptions. the tests show that in the cultivation of corn, the removal of weeds is the all-important object. The Kansas, Illinois, Minnesota and Missouri stations and the United States Department of Agriculture have obtained conclusive results showing the great importance of the weed factor. Corn hoed by hand to prevent weed growth, without stirring the soil, has yielded as much as corn thoroughly cultivated. As an example of such experiments, those at the Kansas station, conducted upon a heavy silt loam, are represented in Table V, which gives the average yields of corn variously cultivated in 1914-1921, inclusive.

Table V—Method of Cultivation Test Summary, 1914-1921

	1914	1915		1916			1917		1919	1920	1921	
		Upland	Bottom	Fall Plowed	Spring Plowed	Not Plowed	Fall Plowed	Not Plowed				Aver. of Seven yrs.
Ordinary cultivation	13.0	60.1	70.0	44.7	43.9	45.3	44.4	34.9	27.7	74.8	60.1	47.0
Ordinary cultivation plus one-horse cultivator, as per judgment	13.3	57.3	66.7	44.5	46.5	39.0	45.4	33.5	26.1	77.5	63.9	46.7
Ordinary cultivation plus one-horse cultivator every 10 days	11.0	52.1	65.5	42.7	46.1	41.5	44.8	34.4	24.3	76.3	64.5	45.8
No cultivation, weeds scraped	9.2	58.6	71.4	44.0	46.8	45.0	40.6	29.4	25.7	73.8	65.7	46.6

Where weeds have been removed by hand-hoeing, the yields of corn have been about the same as where the corn has been thoroughly culti-

vated. Thus with inter-tilled crops, when the fields are free of weeds, it is not profitable to cultivate, unless the soil is of such type as to bake and crack. The high cost of tillage may be lowered by reducing the amount and depth of cultivating.

Two-row cultivator at work.

Other Reasons for Cultivating

At various periods throughout the history of corn cultivation, several other beneficial results have been attributed to proper cultivation. Some of the common reasons are to:

1. Conserve moisture.
2. Make plant food more available.
3. Retard soil erosion.
4. Mix the soil constituents.
5. Improve the physical condition of the soil.
6. Germinate dormant weed seeds.
7. Give the plants a loose soil in which the roots will grow better.
8. Cover organic matter.
9. Control the soil temperature.

Under some conditions any or all of these desirable factors may be accomplished to a certain extent. But, as previously pointed out, the killing of weeds appears to be the only factor that has a great effect on the crop that year or following years. Soils lose large quantities of soil water, but this loss is due chiefly to utilization by the growing crop, transpiration from growing weeds, or internal evaporation and escape

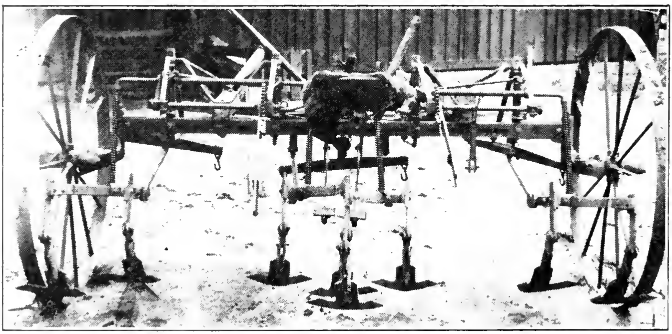
of water vapor. Only methods of tillage which will prevent loss from these sources are of value so far as the water in the soil is concerned. Excessive run-off may be retarded and the absorption of water by the soil may occasionally be aided by proper methods of surface tillage.

Types of Cultivators

There are a large number of corn cultivators in use today. Different ones are of special value for different conditions and times of cultivation. However, the right cultivator should be used at the right time and under the conditions to which it is adapted. Cultivators may be divided into the following classes:

1. Shovel cultivators—(a) with small shovels; (b) with large shovels.
2. Surface cultivators—blade or sweep.
3. Disk cultivators—(a) surface planted corn, (b) listed corn.
4. Harrows—(a) spike-tooth, (b) weeders.
5. Miscellaneous cultivators—(a) one-horse, (b) hand hoe.

The first three classes may be divided again according to whether they are of the one-row or two-row type. The latter are becoming common They are of particular advantage on large areas and for later cultivations. The two-row cultivator reduces the time required for cultivation about 45 per cent. Care must be employed when using the



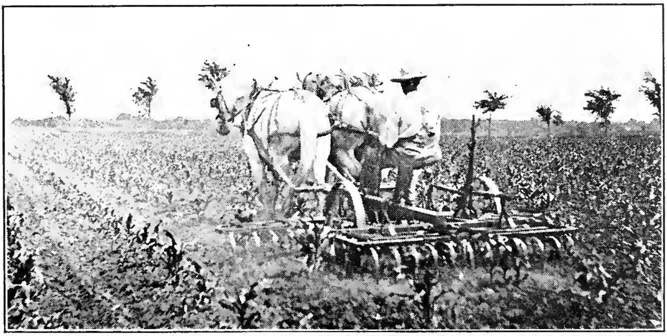
Two-row cultivator with duck-foot shovels.

two-row cultivators for the first cultivation and in crossing checked corn. Another classification may be made according to whether the cultivators are horse or power drawn. At the Missouri station it required forty-two minutes to cultivate three inches deep an acre of twelve-inch corn the third time with a two-row motor cultivator. The cultivation required three-fourths of a gallon of gasoline and one-tenth of a quart of oil for each acre.

The first shovel cultivators were large, and each gang of the machine carried only one shovel. These large shovels stirred the ground

deeply and did considerable injury to the root system of the crop. The tendency in making shovel cultivators has been toward smaller shovels with more of them on each gang of the cultivator. Small shovels are desirable for the later cultivations. There are various shapes of shovels, such as the duck-foot, spearhead and the common or rectangular (sometimes called bull-tongue).

Surface cultivators are characterized by long sweeps or blades that work just under the surface of the ground. Surface cultivators are of particular advantage in the later cultivations. Many corn growers, therefore, substitute blades for shovels on their cultivators after the second cultivation. Large implement concerns state that surface cultivators should be more widely used on loam soils, but that they have grown slowly in popularity because farmers have been accustomed by long usage to the shovel type. The surface cultivator has not found favor in sections of heavy clay or other tight soils. It is an excellent cultivator with which to fight morning-glories, Canada thistles and similar types of weeds.



The weeder or harrow gives excellent results when the corn is small and the ground is not baked.

The disk cultivator is the best type to use on weedy, grassy and sod ground. The disks will cut heavy growth that the shovels will not work in. Most cultivators used in listed corn are of the disk type.

Harrows are excellent for early cultivation. Many weeds may be killed and a large amount of ground cultivated at a low cost with the harrow. Corn may be harrowed right after planting, before it is up, and until it is a foot high. The only time there is any danger of injury to the corn is when the field is harrowed at the time the plants are just coming through the ground. Harrowing will often take the place of one ordinary cultivation. Also, weeders cover a large amount of ground and cultivate corn efficiently, especially when the corn is small.

There may be times after the corn is "laid by"—given the last

ordinary cultivation—when additional single horse cultivation is beneficial. In such case, a special type of one-horse cultivator may be used, or a mower wheel may be dragged through the field. Hand pulling or hoeing of persistent weeds after the corn is "laid by" should be practiced.

Table VI—Implements Used in Cultivating Corn (Illinois Station)

(Bushels Per Acre)

Implements	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	Av.
Small shovels	61.7	**47.5**	44.3	48.0	33.2	67.3	47.2	53.2	36.9	53.0	49.2
Large shovel	61.0	45.2	42.6	45.2	29.1	62.4	47.5	**57.8**	37.7	54.0	48.2
Tower cultivator	64.0	42.1	43.1	**51.6**	33.2	67.1	**50.2**	53.9	**38.1**	49.3	49.3
Disk cultivator	**64.4**	44.3	**46.7**	48.8	**35.6**	**67.5**	47.2	55.1	29.0	**56.8**	49.5

Cultivation Procedure

The first cultivation may be made before the crop is up. While the harrow is more commonly used, some farmers prefer to "blind plow," following the planter marks with the ordinary cultivator before the corn is up. Blind plowing is desirable in fields infested with quack grass or similar weeds. In many cases farmers neither blind plow nor harrow, but begin cultivation with the ordinary cultivator after the corn is about four inches high.

The first cultivation is always in the same direction as the corn is planted. Care should be taken that the young plants are not injured or covered. Either stationary or rotating shields on the cultivator will help to protect the plants from being covered by loose soil. Plants partly or entirely covered at the time of the first cultivation are permanently stunted and are either barren or produce nubbins.

The cultivator should run deeply and close to the row the first time over, so as to cover weeds in the hills. The kernel contains food on which the plant feeds when it starts, hence the roots have not yet grown out where many of them will be disturbed. The first cultivation is the most important. If it is deep and close to the corn plants, it helps to warm the soil, destroys weeds, and loosens the ground so thoroughly that the later plowings are easier.

In checked corn the second cultivation is usually crosswise of the direction the corn is planted. The ease or difficulty of this cultivation is dependent upon how accurately the corn was checked in planting.

After the first cultivation, it is not advisable to run the shovels too deeply or too close to the hills. Allow them to throw in just enough dirt to cover weeds in the hills. A month after planting, the roots from hills, side by side, may be found to meet each other between the corn rows and to be within two and one-half inches of the top of the ground six inches out from the hills of corn. Plowing deeper than three inches close to the hills at this time tears many roots and injures the corn.

Methods of Cultivation

In general, there are two methods of cultivation, (1) level cultivation, (2) hilled or ridged cultivation. Level cultivation is best. Compared to the ridged type of cultivation it has the following advantages:

1. Less surface is exposed for evaporation.
2. Only shallow cultivation is required.
3. The field is more easily prepared for the next crop.
4. Yields are greater.

Depth of Cultivation

Surface culture, which means stirring the soil to a depth not greater than four inches below the surface, cultivates without pruning or injuring the roots of the plant, and forms a mulch on the surface. Deep culture conserves as much soil water as the shallow method, but in most cases the yields of grain from shallow tilled fields have been in excess of those obtained under identical soil and climatic conditions from deep-plowed fields. The difference usually is attributed to the fact that deep culture injures the roots of the plants.

How Cultivation Affects Soil

The cultivation must be suited to the kind of soil. If a field is sandy or easy to work, because it is rich in organic matter, it may be plowed from the beginning with a surface cultivator. Wet, heavy soils should be given deeper cultivation the first time to loosen them up and dry out the surface. If a shovel cultivator is used, it should not run as deeply the second time. A surface cultivator may be used on heavy soils of this type unless there have been heavy rains to pack the soil.

Number of Times to Cultivate

The number of times to cultivate corn will depend upon the number and kind of weeds, the ground in which it grows and the climatic conditions. Keep the corn free from weeds, and try to keep the dirt on top loose—to hold moisture. The growth of weeds in many corn fields shows that such fields are suffering from a lack of cultivation. In others the soil is baked and moisture is lost. When the ground gets too dry after heavy rains, it will dry and crack open. These cracks allow the moisture to escape rapidly, and should be prevented by cultivation. After the corn grows tall, its foliage shades the ground from the sun, and largely prevents both the loss of moisture by evaporation and the growth of weeds. Sometimes, when the season is warm and wet, the corn may grow so fast it is only cultivated twice. The usual number of cultivations in the Corn Belt is four.

Cultivation of Listed Corn

Disk cultivators are commonly used to cultivate listed corn. The disks are set to cut and throw out the weedy fringe the first time over.

A hooded shield is used to protect the plants, especially the first time over. Small shovels are set to mulch the soil in the furrow close to the corn, and large shovels are set to destroy weeds on top of the ridge. The second time over, the corn is a few inches high, and so the disks

Lister two-row cultivator, illustrating method of throwing dirt away from the plants in the furrow the first time over. When the plants are larger, the dirt will be thrown toward them.

are set to throw in, filling the furrow. The shovels are set to destroy and work down the ridge. The disk cultivator is used two or three times, depending on conditions. Often listed corn is "laid by" with an ordinary shovel cultivator. Both single-row and two-row lister corn cultivators are used.

Ways of Reducing Cost of Cultivation

Harrow and disk the field thoroughly before planting, to kill weed growth in its early stages and to make the seed bed firm. If most of the weeds are killed before the crop is planted, later cultivations may be reduced to a minimum. Good preparation of the seed bed will lessen the cost of cultivation. The use of the harrow or weeder for early cultivation is one of the most important labor saving practices. Two-row cultivators save man labor. Remember that the one big object of cultivation is to kill weeds.

Acres Cultivated Per Day

Under Corn Belt conditions, the average number of acres cultivated in a ten-hour day is about as follows:

One-row riding (first or second cultivation), one man, two horses	5.5
One-row riding (third cultivation), one man, two horses	7.0
Two-row riding, one man, three or four horses	13.0

CHAPTER 12

WEEDS OF THE CORN FIELD

THE wheat crop rusts, the oat crop lodges, the cotton crop has its boll weevil, and the corn crop has its weeds. Good corn growing is a constant battle against weeds, and the weed factor is a large one in determining the number of acres of corn to grow. Weeds deprive corn of both moisture and plant food.

Although weeds are one of the worst enemies of corn, the corn field is an excellent place to eradicate weeds that have become a pest in meadows, pastures and small grain. In sections where corn or other cultivated crops can not be profitably grown, the weed problem is a difficult one. To rid their fields of weeds, the farmers must summer fallow, thereby losing the crop for one year. Corn growing is partially replacing summer fallow in many sections, because clean cultivation of corn frees the ground of weeds and the corn crop is not a heavy user of moisture. The crop following corn does nearly as well as after summer fallow, thus showing the importance of killing weeds.

Poor cultivation in June gave foxtail and barnyard grass such a start that the yield of this field was reduced twenty bushels per acre.

Influence of Weeds on Yield*

The most important factor in the growth of a crop of corn on fertile soil with a well-prepared seed bed in humid regions is the killing of weeds. With the same preparation of seed bed, corn produced, as an eight-year average, 7.3 bushels per acre where the weeds were allowed to grow, and 45.9 bushels where the weeds were kept down without any cultivation. This gives an increase of 38.6 bushels, or say $19.30 per acre, for keeping weeds down. Weeds deprive the plant of moisture, light and food, all of which are absolutely necessary for the production of crops.

*Illinois Bulletin No. 181.

The Classes of Weeds

Some weeds produce enormous quantities of seeds, some produce strong underground stems (quack grass) or roots (Canada thistle), that produce new plants, and others produce both seed plentifully and strong underground systems. The weeds of corn may be classified according to the length of their life as follows:

1. Annuals—those that live one year, such as foxtail and crab-grass.
2. Biennials—those that live two years, such as bull thistle and wild carrot.
3. Perennials—those that live more than two years, such as Canada thistle and quack grass.

The annuals and biennials are usually controlled by cultivation, because they grow only from seed. If new weed seeds are kept off the farm, and the weeds already growing are prevented from going to seed, no great amount of trouble will be had from these. Most of the perennial weeds are propagated by underground parts as well as seeds, and the job of eradication is more difficult. To eradicate these weeds, all top growth must be kept down, so that the underground parts will starve. Care must be taken in cultivation so that underground parts are not spread by the cultivator, for small pieces take root and form new patches of the perennial weed.

Use of Smother Crops to Kill Weeds

There are many smother crops that will control weed growth or at least weaken the growth of the weeds so that the pests may easily be eradicated by proper cultivation. Alfalfa, Sudan grass, buckwheat and sorghum are good weed exterminator crops. A heavy seeding of oats acts as a smother crop. For smother crops to be effective, the seed bed must be clean at time of sowing. Fall plowing and thorough cultivation with the disk in the spring, followed by shallow plowing before seeding, checks the weeds severely. The oats should be cut early for hay, before the weeds mature seed. After the removal of the crop, the ground should be disked and plowed.

Common Corn Field Weeds

Some of the worst corn field weeds from the standpoint of number, difficulty in eradication or damage to the corn crop, are:

1. Canada thistle. *Cirsium arvense.*
2. Quack grass. *Agropyron repens.*
3. Wild morning-glory (Bindweed). *Convolvulus sepium.*
4. Black bindweed (Wild buckwheat). *Polygonum convolvulus.*
5. Cocklebur. *Xanthium canadense.*
6. Indian mallow (Butter-print). *Abutilon theophrasti.*
7. Pennsylvania smartweed (Heart's-ease). *Polygonum pennsylvanicum.*
8. Lady's thumb. *Polygonum persicaria.*
9. Foxtail (green and yellow). *Setaria viridis and Setaria glauca.*
10. Crab grass (Finger grass). *Digitaria sanguinalis.*

There are many other weeds often found in the corn field, such as European bindweed, which is one of the worst of all when it gets in a

field, milkweed, horse-nettle, shoofly, lamb's quarter, wild sunflower, barnyard grass, artichoke, ragweed, pigweed and Russian thistle (only in western part of Corn Belt).

Methods of Control

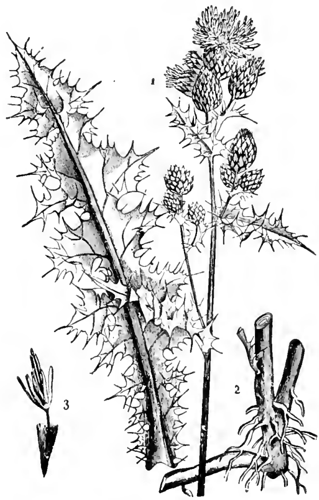
These weeds of corn are classified in four groups, as follows:

1. Weeds which require a special type of shovel on the corn cultivator.
2. Weeds which can not be handled to the best advantage unless the land is put into meadow or pasture for a time.
3. Weeds which require a thorough hand hoeing during late July or early August.
4. Weeds which are common in every corn field but require no attention other than the ordinary three or four cultivations.

First Group

The first group includes weeds like the Canada thistle, wild morning-glory, and European bindweed and other weeds that grow from under-

Quack grass, a bad corn field weed in the extreme northern part of the Corn Belt.



Canada thistle.

ground running roots and from seed. These running roots branch and grow horizontally from the main root. They may be found from a few inches to a few feet below the surface of the soil. At almost any time during the growing season, buds will form on these horizontal roots and send up new plants. The above-ground growth manufactures the food material that is stored in the roots. In order to starve out the plants, it is necessary to keep down all top growth. If the underground growth

is not replenished by food which is made only by the aid of green leaves, all of the food in the underground roots will be used by the growing plant. In time, the plant and roots will die. It is necessary to watch for the introduction of new plants from seed.

Frequent cultivating with spearhead, surface, or duck-foot shovel is necessary so as to keep down the top growth of the weeds in this group. After cultivation is discontinued, the patches of these weeds should be kept down by hoeing. Localized patches where there is a thick stand may be summer fallowed and a crop grown on the remainder of the field. Where thistles are not too firmly established, smother crops, such as alfalfa, grasses, millet and small grains thickly sown and grown for one season give these weeds a set-back which makes easier the eradication by clean cultivation in the corn field the following year. The plants are easily spread by root-stocks that hang on the cultivator shovels.

Second Group

In the second group are weeds such as quack grass and Johnson grass which spread by underground stems in the same way as the first group. It seems necessary to put a field that is badly infested with these weeds into meadow or pasture for a term of years. The pasturing or continued cutting of these grasses brings the underground stems closer to the surface of the ground. Exposing the underground stems by plowing will kill many of the plants. The following crop of corn will afford a good place for thorough cultivation and liberal use of the hoe. This method of control may also be used for the first group.

Foxtail, the most widespread annual weed in corn.

Third Group

Persistent annual weeds, such as the cocklebur, butter-print, black bindweed, wild morning-glory and the Russian thistle are weeds that should be handled by the third method. Ordinary cultivation will not kill all of these weeds in a corn field where they have a good hold. It will require thorough cultivation plus hoeing and hand pulling during late July and August to clean a field. Weeds of this type set an abundance of seed, and so every plant should be eradicated. Plants of the cocklebur a few inches high will mature seed. The bur of this weed encloses a pair of seed, one of which will germinate one season and the other the next season. The seed of the butter-print lives in the soil for ten or more years.

Fourth Group

Most of the ordinary annual corn field weeds are in this class. The most common weeds of this group are the Pennsylvania smartweed, lady's thumb, foxtail, shoofly, crab grass, lamb's quarter, and pigweed. Thorough preparation of seed bed and cultivation as outlined in the previous chapter will rid badly infested fields of these weeds. Heavy June rains which delay the first or second cultivation permit annual weeds of this type to become very serious. In this case, the only practical thing which can be done is to cultivate as quickly and cleanly as the weather will permit. Heavy late summer rains often cause a rank growth of these weeds in August, even though the field was clean at the time of "laying by." Such a growth is not serious, and there is nothing practical to do about it.

CHAPTER 13

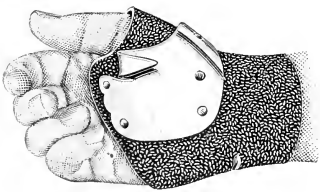
HARVESTING EAR CORN

THE three methods of harvesting that have to do with ear corn are discussed in this chapter, while the other methods of harvesting are taken up in the following chapter. The six general methods of harvesting are as follows:

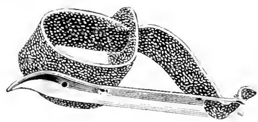
1. Husking the ears by hand from standing stalks.
2. Snapping the ears by hand from standing stalks.
3. Husking the ears by machine from standing stalks.
4. Cutting the stalks for silage.
5. Cutting the stalks for fodder.
6. Harvesting with live stock.

Husking by Hand

Most of the crop in the Corn Belt is husked by hand from the standing stalks after heavy frost. At this time the ears are dry enough to crib



Thumb hook. The husking hook takes an altogether different motion than the peg. Young men who have learned to use the hook find it much speedier.



Husking peg or pin is used by the older generation. Clean work can be done with the peg, but it is slower than the hook.

and they break from the stalks more easily. Before corn is picked, the husks should be dry and the kernels hard. Ordinarily, harvest begins the latter part of October and is completed at Thanksgiving time, but fields occasionally stand throughout the entire winter.

With the use of a husking hook or peg, one man will average about 75 bushels of corn a day, depending upon condition and yield of corn and weather conditions. Records of 100 bushels of corn picked in a day are common. An unusual corn husking record is 261 bushels picked in a ten-hour day. This record was made by Charles Fries, of Rippey, Iowa, working in a field of good corn averaging 60 bushels to the acre. He did not handle the team nor unload the corn, but only picked. Records are based chiefly upon the stamina of the picker, but it is unques-

tionably true that men who use hooks generally make better records than those who use pegs. The hook method of husking was invented independently by R. F. Clark, of Illinois, and Mr. Kees, of Nebraska, about 1895. Young men have found the hook much speedier than the peg, but the older men still cling to the peg, especially in the eastern part of the Corn Belt. The hook, except in the hands of an expert, does not husk quite as clean as the peg.

One man with team and wagon picks two rows at a time in one trip across the field in the direction the corn is planted. The ordinary farm wagon is equipped on the side opposite to the picker with a "bang board," or extension side, against which the picker throws the husked ears. In addition to the husking peg or hook, and gloves, the "bang board" is the only extra equipment used.

Snapping Corn

Snapping is the breaking of the ear from the stalk, but not removing the husk. This practice is common in the south, where corn dries out well and there is danger of injury in the crib from moths or weevils. In the Corn Belt, corn fed directly from the field early in the fall is snapped in order to save the labor of husking. Sweet corn is usually snapped and hauled directly to the cannery. Ordinarily, corn for cribbing is not snapped, because:

1. The husks interfere with the drying of the corn in the crib.
2. The husks take up storage room.
3. The husks interfere with corn shelling, except in the case of big power shellers.

Husking By Machine

Eventually, corn husking machines will be used extensively, but they will come into common use gradually. The machines were used on many large farms during the World war. There has been a great

Husking machines give satisfaction under some conditions.

improvement in the corn picker, and improvement will continue so that the machine will pick up down stalks, catch shelled corn and husk clean in dry weather.

Even now, corn picking machines seem to have been sufficiently perfected so that they are a decided success on the larger farms where all conditions are favorable. All conditions are not likely to be favorable, however, for more than one-fourth of the time with the types of corn which are now most generally grown in the Corn Belt. There is a real opportunity for someone to develop types of corn genuinely adapted to the corn husking machine.

In standing corn, during October, the machine seems to give better results than the ordinary husker, picking many nubbins which most huskers pass up and leaving less in the way of silks and ribbons on the corn in the wagon. With six horses and one man, it will pick on the average about 370 bushels in a ten-hour day. But as the season wears on and the stalks become brittle and some of the ears drop off, the machine seems to labor under a serious handicap. Ideal picking conditions are:

1. Upright, hard shelling corn.
2. Stalks and husks not too brittle.
3. Dry under foot.
4. Cloudy or damp weather.

Heretofore, in the Corn Belt, corn breeders have selected for single-eared types of corn because of the greater labor of husking two-eared stalks. With the corn husking machine, however, there may be a positive advantage in two-eared sorts.

With hand huskers, it is inadvisable for corn to carry the ears much lower than waist high, but with the machine it is permissible for the ears to be as low as two feet from the ground. For the picking machine, it seems that a rather smooth-kerneled, shallow-grained sort which clings tightly to the cob would be better than a deep-grained, rough, easy-shelling kind.

Reid Yellow Dent, and other varieties of corn similarly bred, are responsible for a large part of the difficulty with corn picking machines. Reid Yellow Dent is an ideal variety for hand huskers, carrying a large ear on a small shank and breaking off easily. It is just about the worst possible variety for machine husking.

Even under ideal conditions, when the machine picks cleanly, there are some objections to the mechanical picker, as follows:

1. It requires five or six horses to pull the machine.
2. It is hard on the horses.
3. It tears down the stalks and leaves them in poor condition for pasturing.
4. It is expensive, costing about $400.

Elevating the Corn

The larger Corn Belt farms usually have a portable elevator for delivering the husked corn from the wagon to the crib. These elevators

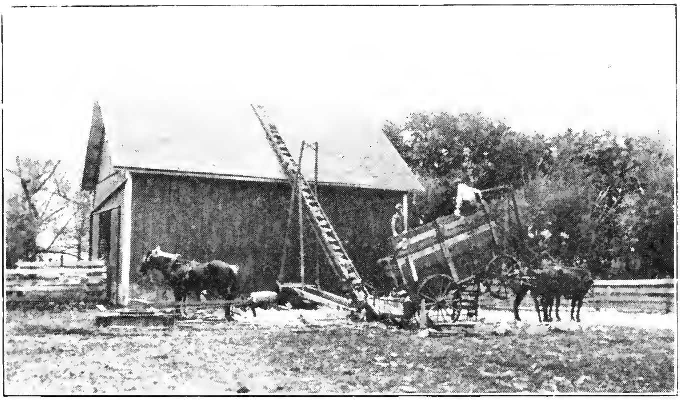
save the large amount of hand labor required when the corn is scooped by shovel from the wagon into the crib. The corn is dumped and elevated by power furnished by a team or gasoline engine. A crib may be entirely filled with no hand labor. For shoveling, the wagon is equipped with a special end-gate, which provides room for the shoveler to stand.

Corn Cribs

A good corn crib should provide for the following:

1. Ventilation.
2. Protection from rodents.
3. Exclusion of moisture.
4. Accessibility to the feed lot.
5. Permanency.

Most of the cribs are of wood with slatted siding. These cribs are of varying lengths, but are quite uniformly eight feet wide, so that good



Cribbing corn with portable elevator.

ventilation is obtained. In years of large corn crops, much corn is placed in temporary wire or stave fence cribs. For permanency, farmers have been building cribs of special hollow tile that has a channel extending downward toward the outside of the crib. These circular cribs with central ventilators and cement floors have proved very satisfactory.

Moisture in Corn

It is not safe to crib in an ordinary crib, ear corn that has over 30 per cent moisture. In an average year at husking time, corn will contain from 20 to 30 per cent moisture. There is a rapid decrease from September to November in the amount of moisture in cribbed corn, and again in the spring months.

From November until the following October, corn will lose from 8 to 20 per cent in weight, depending upon conditions. As a rule, there will be about 17 per cent shrinkage in ordinary corn the first year. The second year there is a small amount of shrinkage in crib corn, usually less than one per cent. (See Chapter 21.)

Measuring Corn

To find the number of bushels of shelled corn in a bin, multiply the length by the width by the depth (all in feet), and divide by 1.25. To find the number of bushels of ear corn, divide by 2.5. If the corn is in the husk, divide by 3.5. For a round crib, multiply the distance around the crib by the diameter by the depth of the corn (all in feet) and divide by 10 to get the number of bushels of ear corn; if the corn is in the husk, divide by 14.5. A common wagon box is 10 feet long and 3 feet wide. It will hold two bushels of shelled corn or one bushel of ear corn for every inch in depth. There are 2,150.42 cubic inches in a bushel of shelled corn, and 4,300 cubic inches in a bushel of ear corn (allowing 70 pounds of ear corn to the bushel). In the case of unusually deep grained, smooth-dented, well-matured corn, 3,800 cubic inches of ear corn may shell out a bushel.

Pasturing Corn Stalks

A valuable by-product of the husked corn crop is the excellent pasture afforded by stalk fields after husking. A majority of Corn Belt farmers turn live stock into a corn field as soon as the field has been husked. A stalk field furnishes a good place to winter over cattle and horses. The live stock break down the stalks, aiding in preparation of seed bed in the spring. Pasturing of stalks in wet weather is a disadvantage, especially on heavy soils, as the live stock will pack the soil.

Shelling Corn

Ear corn not containing more than 25 per cent moisture will shell readily, and in the frozen state corn with more moisture will shell. However, it is not safe to bin shelled corn containing more than 19 per cent moisture. If shelled corn is to be stored beyond April 15, it should not contain more than 17.5 per cent moisture, or it is likely to heat seriously during the first spell of warm weather. Grade 3 corn, which contains not more than 17.5 per cent moisture, may be safely shipped in warm weather.

The two types of corn shellers are spring sheller and cylinder sheller. Most of the small power shellers and hand shellers are of the spring type. These shellers have an adjustable rag iron that holds the ears against a deep grooved wheel that shells the corn from the ear as a large wheel revolves the ear, so that the kernels are removed from the entire ear. Blowers for cleaning, cob stackers, and elevators are part of most of the power types. The cylinder sheller is usually a large power

machines. The corn is shelled by the revolving of shelling rings within a cylinder cage. A common objection to this type of sheller is the broken cobs and cracked kernels that result. Large shellers of this type will shell as many as 350 bushels in an hour, and will handle "snapped" corn fairly well.

Time Required for Husking

According to the 1922 Yearbook of the United States Department of Agriculture, about the following number of bushels may be husked in a ten-hour day:

	Bushels
From shock, by hand, one man	45.0
From standing stalks, by hand, one man, two horses	85.0
From standing stalks, by machine, one man, six horses	375.0

CHAPTER 14

SOFT CORN

SOFT corn contains from 25 to 65 per cent moisture. It is only in very unusual years, such as 1902, 1915 and 1917, that much of our central Corn Belt corn will contain over 25 per cent moisture in December. In such a year, the following information is of great value.

Soft corn usually falls in the "sample" grade, for it contains over 23 per cent moisture in addition to damaged grains. To classify soft corn simply upon the amount of moisture present, the following approximate grading was made by the Iowa station:

Percent Moisture	Grade
65	Markedly soft (rare)
55	Very soft
45	Soft
35	Fairly soft
25	Cribable
20	Safe corn
14	Old corn, mature
12	Usually two-year-old corn
8	Usually kiln-dried

Ways of Utilizing

It is best to leave soft corn in the field as long as possible because it will dry more rapidly. However, special precautions must be made for the use of the crop. The following are a number of methods of using the soft corn crop that are suitable for different conditions:

1. Ensiling
2. Shocking
3. Cribbing
4. Shredding
5. Marketing
6. Feeding

Silage

The silo is an excellent place for storing soft corn. Usually, it is safe to add water, but the aim always should be to produce a silage that will run from 60 to 70 pounds of water for 100 pounds of material as it is taken from the silo. Ordinary mature dry fodder corn which is siloed in January and February will require about a ton of water with every ton of fodder. Some years soft corn will require the addition of no water for silage.

To ensile the soft ear corn without the stover is practical. Soft corn ears in the late roasting stage or silage were husked, run

through a silage cutter and tightly packed into small silos, in a test at the Iowa station. The silage resulting after twelve days of fermentation (ordinary silage is practically made in ten days) was good. It had a favorable odor, much like ordinary corn silage. It was bright, light colored, free from mold, and palatable. Such corn grain and cob silage will not develop as much acidity as ordinary silage, but enough to preserve it if properly cut up and packed. At the end of two months this soft ear corn silage was in excellent feeding condition. "Snapped" corn (ear plus husks) will make good silage. The husks are of advantage in that they will tend to tie or pack the small ear pieces closely together and hold the desirable moisture.

Shocking the Soft Corn Crop

Shocking the corn in small shocks will help to save the stover, which is of high quality in a soft corn year. Shocking will be of further advantage in that the ears will dry out rapidly, especially in dry weather. In a favorable season, the ears really dry out so as to make a little better feed than if allowed to dry out and weather on the stalk. However, in a wet season there is some risk in the shocking process.

Cribbing Soft Corn

Usually corn is safe to crib when it contains not more than 33 per cent moisture. The more mature corn, from the hillsides, the high ground and the earlier plantings, may advantageously be stored in the crib. The silks and husks and other foreign material tend to hinder ventilation and promote souring and molding. The softest ears should be separated and fed early if practicable. The wagon bed may be divided into two bins, one in front for soft corn and one behind for hard corn. Another place where sorting is practical is at the crib if an elevator is used. The soft ears may be picked from the elevator chute and thrown out, while the mature ears are allowed to proceed upward. The crib should be off the ground to aid ventilation. The six or seven-foot crib excels the eight-foot in the soft corn year.

Crib ventilation by special devices is valuable. Fill the bed of the crib about two to three feet deep with ear corn; place the ventilators on top of the corn, running them lengthwise with the crib. Fill in another two or three feet of corn, place more ventilators, and so on until the crib is filled. These ventilators are best made out of 2x8's set on edge side by side about 8 to 12 inches apart. Nail cross cleats on the top as well as on the bottom of the two parallel 2x8's, so as to form a long, rectangular, open box. Instead of slats or cleats, a substantial grade of galvanized or plain wire mesh may be used. To keep the 2x8's from collapsing and to prevent filling with corn, the cross cleats should be liberally provided. There is another simple ventilator built like a hog trough. It is placed in the crib in a horizontal position and turned face downward. The air can not proceed upward through this trough, for

the only opening is on the inverted side. Lay either of these types of ventilators in the crib about two to four feet apart. A six-foot crib should usually have two ventilators running lengthwise. In placing the ventilators of the second set, place them midway between, not directly above the ones first placed on the next lower level. Put the third set directly over those of the first set, and so on.

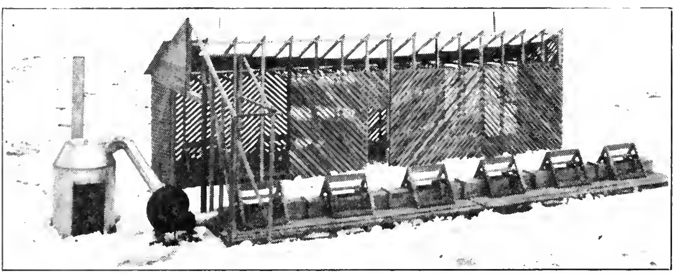
Vertical ventilators may be used. These ventilators are usually made of eight to twelve-inch tile. They should extend from the floor of the crib to the roof. Between the tiles place a couple of 1x1's or 2x2's, to allow the air to enter the tile at every joint. The first horizontal ventilators previously described may be used vertically.

Use of Salt

Tests by Hughes at the Iowa station show that salt is of value in retarding fermentation and the development of molds in soft corn. In cribbing soft corn, from one-half to one pound of salt for each 100 pounds of soft corn may be used, the amount depending upon the condition of the corn. While two pounds of salt per 100 pounds of corn appears to give noticeably better results than one pound, it is probable that this amount of salt can not be used safely when the corn is to be fed to live stock. If stored under favorable conditions, the use of salt will not prevent the development of molds or of heating, particularly in ear corn. Therefore, it is necessary to use the greatest care in providing the best ventilation possible. Especially soft ears and ears which are already damaged should be sorted out before placing the rest of the corn in the crib. The effect of the salt in preventing shelled corn from heating and molding should be of value when such corn is shelled and shipped, before it has thoroughly dried. The great danger of soft corn heating when in storage and transit is well known.

Use of Heat

Soft corn has been dried out in the crib at a low cost by a method originated by the Iowa station. Ventilators are placed underneath a



Model of the Hughes hot-air drier, which has been used very successfully in making soft corn cribbable.

crib and heat is forced by means of a hot-air furnace and blower through the corn. A series of trap doors allows drying out of small sections of the crib at one time. In tests, the moisture content of crib corn was reduced from over 30 per cent to less than 10 per cent, at a cost for fuel and power of less than five cents a bushel. One northern Iowa farmer dried 3,000 bushels of soft corn in one crib by this method at a cost of less than one cent a bushel.

Shredding

Shredding soft corn is usually unsatisfactory. It is hard to shred because it is sappy, and, furthermore, if it is not well dried out it will spoil in storage. Some farmers recommend the addition of salt, about five to twenty pounds to the ton. If necessary to shred, it is well to shred often, and not store too large a quantity of shredded material. It is well to put off the shredding to the latest possible date, so that the corn will be well dried out in the shock.

Marketing

In marketing soft corn, it is well to shell in a frozen condition and haul it to market in the frozen state. Inasmuch as a premium is paid for the most mature, hardest corn, it is well to sell that and feed the soft ear corn. It is surprising how much water in a frozen condition ear corn can carry in the grain. Even though not frozen, corn with as much as 25 per cent moisture will shell readily.

Feeding

The feeding of soft corn is the most logical method of disposition. There are two essential precautions: Feed early while the quality is still good, and feed often—three, four and more times a day. Moldy corn is dangerous for horses and young sheep. But hogs may usually be trusted to eat what they will.

"Moldy corn," says Dr. R. E. Buchanan, "has often been suspected of poisoning cattle and hogs. Investigations carried on in recent years seem to indicate, however, that this rarely, if ever, occurs. The diseases or sickness of cattle which once were supposed to be due to mold poisoning have since been found to be due to infection with hemorrhagic septicemia or other diseases which have nothing whatever to do with mold on corn. It seems, therefore, that there is no good reason why corn showing more or less mold can not safely be fed to cattle and hogs.

"The molds which appear are sometimes blackish, sometimes bluish, greenish or pinkish in color. If these molds are not present in excessive amounts, that is, the corn is not actually rotten or matted together by the mold, it is not probable that cattle and hogs will be injured by eating it.

"What has been said above, however, should not be used as justification for feeding moldy corn to horses. Many instances are on record of horses being killed by eating moldy silage, moldy corn, and moldy

forage of other types. Whether or not it is the mold itself or some other organism growing in the moldy corn that causes the trouble is at present uncertain."

Food Value of the Crop

The yield of dry matter in corn at different stages, on the acre basis, as figured from Indiana results of Jones and Huston, on a basis of 100 as final mature yield, is as follows:

Table VIII

Stage of Growth	Corn plus cob (ear)	Stalks, blades, husks, etc.—Stover	Entire corn plant
Four feet high	....	....	7.76
First tassels	....	....	23.85
Silks drying, kernels forming	14.56	90.21	48.53
In the milk	43.73	92.41	65.59
In the glaze	74.56	100.00	86.11
Well dented	89.19	101.84	94.87
Ready to shock	100.00	100.00	100.00

In the early kernel stage, less than 15 per cent of the dry matter found at maturity has been laid down in the ear, and only 44 per cent in the milk stage. If frost comes when the milk still shows plainly, the yield is approximately half in dry matter, as compared to the normal matured yield. The stover contains more than 90 per cent of the total possible dry matter as early as the milk stage. Therefore, in frosted corn the greatest damage in yield is to the ears.

CHAPTER 15

CORN FODDER

CORN fodder is the source of a large amount of feed for all types of live stock. The entire plant, including ears, is referred to as corn fodder, while the stalks without ears are called corn stover. This chapter will deal with both corn fodder and stover, and also the method of handling corn for silage up to the time it is ready for the silo. Chapter 16 discusses the making of corn silage.

Varieties of Corn for Fodder

In the present state of our knowledge, the safe thing for most Corn Belt farmers to do is to stick by the regulation grain sorts as commonly grown in the community, since the grain is the most valuable part of the plant. Approximately 60 per cent of the digestible food materials present in the corn plant are found in the ears, and 40 per cent in the stover. Eventually we shall do as in New York and New England, where they almost invariably use a different variety for fodder than they do for grain. Our present varieties are not perfect. They blow down too easily. A two-eared sort of Reid or Leaming might be well worth while for fodder and silage and a little later sort may well be used for fodder than for grain.

The large, late maturing varieties from the southern states have in some cases given a larger amount of dry matter than the adapted local varieties, but as the difference is relatively slight and the quality of fodder and silage relatively poor, and a much greater tonnage of green fodder must be handled, owing to the greater percentage of water in the more immature southern varieties, those adapted to the locality are considered more profitable.

It is desirable to plant corn which is to be used for fodder just as early as if the crop were to be harvested for grain only. The corn should mature early enough to be ready to harvest before frost, as only in that way is the maximum yield of dry matter obtained. In some instances, when it has been found necessary to plant a field of corn rather late in the season, it has been found desirable to use the replanted corn for fodder, as the crop will often become sufficiently mature before frost to make a fair quality of fodder and silage when it would not do to crib.

Method of Planting

It really makes little difference whether corn for fodder is drilled or checked. If the land used is very weedy, checking undoubtedly will be the safest method, as the weeds can be better kept under control by cultivating in both directions. On clean ground, drilling is often preferred, as the plants will be more uniform in size and the corn binder will run more smoothly, since the stalks are cut one at a time. On very fertile, clean ground, a somewhat greater yield may be secured by drilling.

Rate of Planting

Corn for fodder may be planted a little thicker than for grain, as a greater yield of both grain and fodder usually will result. The rows are placed three feet six inches apart and the kernels dropped so that there will be one stalk every nine or twelve inches in the row when drilled or three to five stalks per hill when checked. The thickness of planting should depend somewhat upon the fertility of the soil, the variety, the amount of rainfall in the region and to some extent upon the length of the growing season. If the corn is planted too far apart, the stalks grow rank and woody, there is a tendency to mature late, and also the yield will be reduced. On the other hand, corn may be planted too thickly to be desirable for silage. If too thick, the plants lack substance and shrink badly in the silo, the percentage of grain is slightly reduced and there may be a greater tendency for the corn to blow down.

Time to Cut

The best results are obtained when the kernels are well dented and hard and the lower leaves of the plant turned brown. At this stage, the corn plant has its greatest feeding value. In addition, it is in good condition to put in the silo.

Although there is some difference of opinion as to the best time to harvest corn for silage, it is generally conceded that immature corn does not make the best quality of silage. When corn is cut too early, the silage has a dark color, contains too much acid and some of the feeding value is lost. Some farmers prefer greener silage for feeding to dairy cows than for feeding to beef animals. For the value of corn at different stages of growth, see Table VIII, Chapter 14.

Of course, it is desirable not to allow the corn to become fully ripe because the plants become more woody and leaves are lost. If, how-

ever, the corn becomes over-ripe before cutting, a good quality of silage can be made if a little water is added by running it into the top of the blower with a hose while the silo is being filled. Sufficient water should be added to make it possible to pack the silage firmly.

Method of Harvest

Corn may be cut either by machinery or by hand. Hand cutting is seldom practiced, but is sometimes resorted to when the corn is blown down so badly as to prevent harvesting with machines. It is well to make the bundles rather small, for while this will take more twine, the bundles may be shocked and loaded on the wagons more easily, and also they will feed into the silage cutter somewhat better.

Shocking Corn Fodder

Ripe corn should be shocked as soon as it is cut. If the corn is green and full of moisture, it should be allowed to lie on the ground for a few days. The shocks should be large, containing about forty medium sized bundles. Two men working together can build a firm shock by setting the bundles in an upright position, the butts firmly on the ground, and bracing the shock from all sides. The tops of the bundles may be closely compressed together with a small rope that has a ring in one end. Binder twine may then be used to hold the tops together and the rope released for use on the next shock. A shock of this type should stand a year with a minimum amount of waste.

Losses in Corn Fodder

There is a loss of feed value in both silage and fodder. However, the loss in the latter is greater. No matter how well shocked, corn fodder will lose in value. Corn fodder or stover standing in the field for a few months, according to Henry and Morrison, loses 20 per cent of the dry matter it contains, due to weathering and fermentation. They say that the losses are in the sugar, protein and starch, the most valuable parts.

Utilization of Fodder

Corn fodder may be utilized in any of the following ways:

1. Soiling crop—cut green and fed.
2. Dry corn fodder—cured in the shock.
3. Shredding—ears removed and stover torn in small pieces.
4. Stover—ears removed and stover fed.
5. Silage—discussed in Chapter 16.
6. Miscellaneous uses.

Corn as a Soiling Crop

Because of poor pastures in the late summer, many farmers feed green corn to their live stock. Usually the corn is cut daily and fed. This corn is palatable and relished by all kinds of live stock. More corn

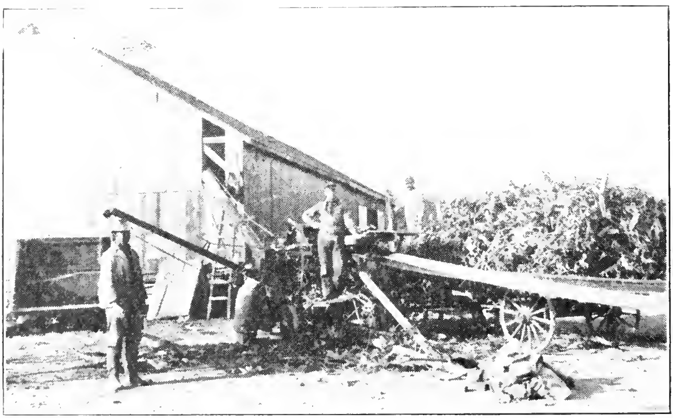
is used this way than is generally realized. Sweet clover and early varieties of dent corn may be used to good advantage, for they are ready to feed early in the season.

Dry Corn Fodder

The cured corn fodder (shock corn) may be fed directly from the shocks or from stacks where it is stored for ease in feeding. Fodder should not be put in stacks or mows until it is cured. The stacks should be narrow and not over ten feet high, and it may be advisable to put layers of straw or hay between the layers of fodder bundles. There is some waste in both corn and stover in feeding fodder. It is not nearly so valuable as silage. Corn may be thickly grown and cured to make a coarse hay.

Shredding

Most of the shredding machines now used husk the ears from the fodder and then tear the stover into small strips. The husked ears are elevated into a wagon and the shredded stover is elevated or blown into



Shredding corn fodder.

the barn or stack. The shredded stover is easily handled, and there is less waste than in ordinary stover. The shredded stover makes good bedding. Large piles of shredded stover heat easily, especially if the stover is green. The addition of salt helps to keep down heating. Usually, shredding is done late in the season.

Corn Stover

Often the ears are removed from shock corn and the stover fed directly to live stock as a roughage. The stover of small, early varieties

as grown in the northern Corn Belt is of good quality. Stover may be fed to all classes of live stock and will "carry over the winter" cattle and idle horses.

Miscellaneous

In some sections, especially in new regions where machinery is scarce, corn fodder is run through an ordinary threshing machine. The grain is shelled and the stover blown into the barn or stack. In the south, corn is topped—stalk cut off just above the ear—and the leaves are stripped from the stalk for feed. This practice is often followed to hasten maturity. However, the practice is not recommended, for it reduces the yield of ear corn very greatly.

Standard Day's Work

Under favorable conditions, the following number of acres can be handled in a ten-hour day:

Cutting:

Binder, 40-bushel corn, one man, three horses	8.0
Platform cutter, 40-bushel corn, two men, two horses	6.0

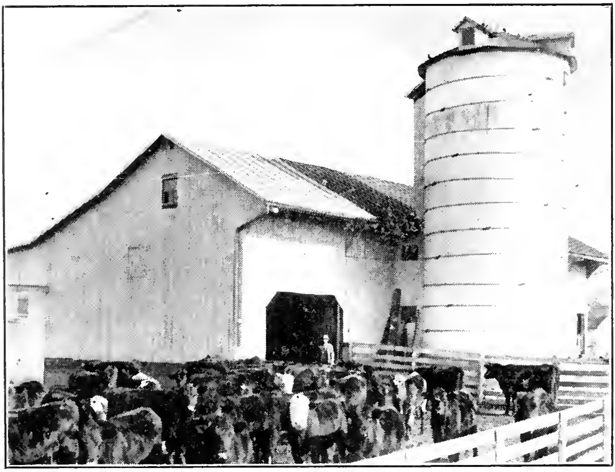
Shocking and cutting by hand:

After binder, two men	3.6
Cut and shock by hand, one man	1.4

CHAPTER 16

CORN SILAGE*

SILAGE aids the farmer to utilize fully the food value of the crop which he produces. Corn properly stored in the silo saves more of the food value of the plant than is possible by any other method. Not only is there a saving in food value, but the crop may then be fed practically without waste. Silage is very palatable and is readily eaten by almost



Silage is a cheap feed for fattening cattle.

all classes of farm animals, being especially well suited for cattle and sheep. Silage furnishes a succulent feed in winter when greatly needed and is also a valuable supplement in late summer and early fall when pastures are likely to be short. When corn is harvested as silage, the farmer is less dependent upon the weather and the crop is stored in a smaller space and more convenient form for feed than it is possible to store the same amount of corn as dry fodder.

Number of Silos

The use of silage crops dates back to the time of Caesar. The Romans stored green feeds for their horses in the ground. The Germans

*Varieties, planting and harvesting corn for silage are discussed in Chapter 15.

made use of silage for animal feed many centuries ago. However, silos have been in use in the United States only during the last half century. Since their introduction, the number has increased rapidly, until the "watch towers of prosperity," as they are called, dot the entire Corn Belt and the great dairy states.

There are about half a million silos in the United States, of which about one-third are found in the dairy sections of Wisconsin, New York, Minnesota and New England. In the dairy sections, silos are found on every third or fourth farm, whereas, in the Corn Belt proper, silos are found on about one farm in ten.

Kinds of Silos

There are many kinds of silos in use today, but there are only two general types of silos, as follows:

1. Pit silos—built partially or wholly below ground.
2. Above-ground silos—built of wood or masonry.

The first type is found only in the western edge of the Corn Belt and the plains section. The second type includes nearly all the silos of the Corn Belt. No attempt will be made to describe the building of either type. But the desirable features of a well-built silo may be stated as follows:

1. The walls should be as air-tight as possible.
2. The walls should be strong enough to resist the pressure of the silage.
3. The inner surface of the wall should be smooth.
4. The location and construction of the silo should prevent freezing.
5. It should be built to resist high winds.
6. It should be cylindrical in shape and have plenty of depth.
7. It should be convenient for filling and emptying.
8. The foundation should be durable and extend below the frost line.
9. A permanent silo of neat appearance adds much to the farm.
10. The silo should be simple in construction and low in cost.

What Silage Is

Silage is finely chopped green material packed in an air-tight receptacle. All reference, unless otherwise noted, will be to corn silage, for it is the common silage used. The making of silage is a fermentation process, which begins as soon as the silo is filled. The following changes are brought about:

1. Increase in temperature—85 to 90 degrees F.
2. Evolution of carbonic acid gas—dangerous in pit silos.
3. Change in color—darker.
4. Aromatic odor—desirable.
5. Formation of acids—1 to 2 per cent of weight.
    (a) Lactic acid—acid of sour milk.
    (b) Acetic acid—acid of vinegar.
6. Formation of alcohols—1 to 4 per cent weight.
7. Breaking down of proteins—no loss to silage.

These changes, which are bacterial, physical and chemical, are practically completed at the end of two weeks, and the silage is made. Silage

may be kept for years in a tight silo without loss of palatability or value. However, it is important that the silage be we'l packed and the silo tight, because air permits the development of molds, which are sometimes poisonous, and which quickly destroy the acids and thus allow the silage to spoil. Bacteria which cause decay will not live and work in the presence of lactic and acetic acids when no air is present.

Common Yields of Silage

Under average conditions, a fifty-bushel crop of corn will produce from eight to twelve tons of silage per acre. Assuming that a ton of silage contains five bushels of corn, crops, yielding 30, 40, 50, 60, 80 and

Low-down racks save labor at silo-filling time.

100 bushels per acre will produce in the neighborhood of 6, 8, 10, 12 and 20 tons of silage per acre, respectively. However, the variety, soil, rate of planting, etc., will cause the number of bushels in a ton of silage to vary from three to eight.

Culture of Corn for Silage

Most Corn Belt farmers handle corn for silage in the same way that they do for grain. However, the possibilities of particular varieties, increased rate of planting, and time and method of cutting corn for silage are thoroughly discussed in Chapter 15.

Filling the Silo

Most of the corn fodder for the silo is hauled on ordinary racks. There are some advantages in loading if a low-down rack is used. The general custom is to have about seven wagons hauling, with an extra

man at the cutter to help unload. Bundles are laid flat on the rack, with butts one way. Usually the bundles are hauled as soon as the corn is cut.

The man who feeds the corn to the ensilage cutter affects very directly the progress which is made. He determines the length of the pieces into which the silage is cut. An important precaution is to see that the knives of the cutter are sharp at all times. Two or three sets of knives are maintained for most cutters, so that they may be changed or re-sharpened once or twice a day.

Adequate power to drive the cutter is another pre-requisite to efficient silo-filling, whether the source of power be a gas tractor or a steam engine. A large cutter and a small engine will slow up the operations. Reserve power is highly important if the cutter is to be run smoothly and do the best work.

Short Lengths

Much difference of opinion exists regarding the length to cut corn for silage. Some farmers prefer one and one-half inches, while others advocate cutting not over one-half inch. The longer cuts are more economical of power and the silo may be filled more rapidly, but the silage will not pack as closely in the silo. Therefore, it may not keep as well, and in addition there is more waste in feeding. All things considered, the one-half inch or three-quarter inch cut is probably the most desirable, as it packs readily and feeds out with but little waste.

Distribute and Pack Well

The heavy and light portions of the finely-cut corn must be uniformly distributed. The heavy part of ears and stalks should not be in the center or on one side, and the lighter part, such as leaves, on the other side, as settling will be uneven and much spoiled silage will likely result. In order that the full capacity of the silo may be utilized, and at the same time insure a good quality of silage, it is essential to distribute the cut corn uniformly and tramp firmly all parts of the silo, especially the outer edge. The work of distributing the cut corn and packing it is greatly facilitated by the ordinary distributor.

When a large quantity of corn is placed in a silo within a short time, a considerable settling of the silage results, making it necessary to refill the silo within a few days in order to utilize the full capacity of the silo. Where two silos have been built side by side, filling one for a day and then filling the other for a day until the two silos are filled, will partially overcome the difficulty from settling.

Adding Water

If corn is cut at the proper time, good silage can be made without adding water. Corn in the silo at filling time should feel moist. Briefly, water should be added to corn when filling the silo under the following

conditions: First, when corn is too ripe and does not pack well in the silo; second, when refilling the silo in the late fall or winter with dry shocked corn.

Preventing Waste on Top

Unless feeding is commenced as soon as the silo is filled, some corn at the top of the silo will spoil. This waste may be partly eliminated in several ways. First, level off the surface and tramp firmly. Some farmers use finely cut straw or chaff from the straw stack thoroughly packed and wet down, to cover the top. Others soak the top with water and sow oats. The oats sprout and make a thick covering which keeps out the air and reduces the waste. Satisfactory results have come from the use of tar paper spread over the surface and covered with a thin layer of cut corn from which the ears have been removed. In any case, it is a good plan to pull the ears off the last load of corn which is put into the silo.

Opening the Silo

Corn may be fed as soon as the silo is filled, but for the first few days, it is nothing but green corn finely cut. When handled in this way, there is no waste on the top of the silo. During the first ten days or two weeks, fermentation takes place, and the corn is gradually changed to silage. When allowed to stand for a time before using, some corn at the top of the silo will spoil and before feeding is begun this spoiled layer should be removed.

Refilling the Silo

After the contents of the silo have been fed out, the silo may be refilled with dry shocked fodder, if it is available. Dry corn put in the silo makes a very satisfactory feed, but it is not as high in value as silage from corn put in at the proper stage. In refilling a silo with dry corn fodder, about 250 gallons, or one ton, of water should be added to each ton of dry fodder. The water may be run in the top of the blower with a hose. It is not desirable to allow the water to run in one place, as it will follow channels, and leaves parts of the silage practically dry, resulting in much spoiled feed. Corn stover may be used in the above way. However, its feeding value is much lower than silage made from fodder. These types of silage should be made not later than February 1.

Frosted Corn Silage

If the corn which is to be used for silage is frosted while still quite immature, it is best to cut it soon after frost, to avoid loss of leaves and allow the corn to cure out to some extent before putting it in the silo. In 1915, when much immature corn was harvested for silage, many farmers cut their frosted corn, cured it in the shock, and filled their silos later in the season, adding water to facilitate the pack-

ing of the silage. Some of the farmers who put this kind of corn into the silo immediately, found that the silage produced was very watery. Soft corn silage is discussed in Chapter 14.

Corn Silage Versus Other Silage

As far as its content of protein and sugar is concerned, the corn plant furnishes the most nearly ideal single plant material for silage. Plants similar to the legumes contain too much protein material in proportion to the sugar content. Sunflowers give a large tonnage, but a coarser silage. Dairy sections in the southern Corn Belt infested with the chinch bug have grown sunflowers for silage with only fair results.

Legumes, especially soy beans, have been mixed with corn for silage. Ordinary corn and soy bean silage, resulting from growing the two crops together in the same field, usually has ten parts of green corn to one part of soy beans. The Indiana experiments indicate that the advantage of corn and soy bean silage is more theoretical than actual. Apparently, any slight increase in the value of the silage per ton, or in the yield of the mixture per acre, is counterbalanced by the cost of the soy bean seed and by the extra bother involved in handling the mixture.

Characteristics of Good Silage

In buying, feeding or judging silage, it is well to know the characteristics of good silage. Good silage should have the following characteristics:

1. Cut in short half-inch lengths (not long shreds).
2. Very leafy with few coarse stalks.
3. A large amount of grain in the stover.
4. Sweet and free from all molds.
5. Sharp odors of acid.
6. No odor of spoiled butter.
7. Even distribution of moisture.
8. From 60 to 74 per cent moisture.
9. Light in color.
10. Palatable.

Measuring and Valuing Silage

To measure silage, square the diameter and multiply by .7854, and then by the depth of settled silage. This gives the number of cubic feet. If not much silage has been fed out, allow 40 pounds to the cubic foot. In the bottom one-third of the silo, allow 43 pounds per cubic foot. A ton of average Corn Belt silage is worth the value of five bushels of corn plus 300 pounds of loose hay.

CHAPTER 17

HARVESTING WITH LIVE STOCK

THERE are three general ways of harvesting the standing corn crop with live stock. Hogging-down, however, is the only common practice. These ways, in the order of their importance, are:

1. Harvesting with hogs—hogging-down.
2. Harvesting with sheep—sheeping-down.
3. Harvesting with cattle and horses.

Hogging-Down

Hogging-down corn is a practical and efficient way of gathering the crop and feeding spring pigs which are to be finished for the early winter market. Farmers who have tried it are almost unanimously agreed that the method is economical and successful. The most enthusiastic hogging-down men are those who have followed the method longest. Tests show that hogging-down gives as good results as dry lot feeding.

Fifteen advantages of hogging-down, according to the Iowa station, are:

1. Labor is saved.
2. Storage charges on corn are saved.
3. Returns are equally as good.
4. The hogs develop good constitutions.
5. No manure is lost.
6. The manure is evenly and uniformly distributed.
7. The crop is harvested without waste.
8. The weeds may be cleaned up.
9. Hogs may follow cattle in the field.
10. Facilitates and encourages the gathering of seed corn.
11. Poor stands of corn may be taken advantage of.
12. Under certain conditions brood sows may be run in the field.
13. Fall plowing is sometimes possible.
14. Organic plant material will be largely added.
15. Corn is harvested more quickly.

However, the practice has some drawbacks. Twelve disadvantages, according to the Iowa station, are:

1. Hardens the soil if pastured when wet.
2. Some waste of corn in wet weather.
3. A loss of stover.
4. Difficulty of fencing.
5. Brood sows and gilts get too fat.
6. Takes extra care to turn hogs into new corn.
7. Heavy hogs may waste some corn.
8. Hogs do not gain well after hogging-down.

9. Likelihood of neglecting hogs.
10. More liable to sickness.
11. Stalks are hard to plow under.
12. Several minor disadvantages.

Variety of Corn to Use

The highest yielding corn which is adapted to the locality is the variety to use for hogging-down. The hogging-down season may be lengthened by having a small field of an early variety of corn on which to turn the hogs early in the fall. In the North, hogging-down is the only practical way of harvesting short-stalked varieties such as the early flints. Sweet corn does not produce as much pork as field corn, because it does not yield so well.

The Principle to Follow

The Iowa station says that hogs can gather their own corn to advantage by making efficient use of the grain eaten as they carry on their labor-saving and fattening campaign. However, results show that in the corn field, as in the dry lot or in the pasture, the same general principles of nutrition govern the hogs' appetites, digestion assimilation, growth and fattening. It is necessary to know where the protein is coming from to grow the pigs. Although corn field weeds, such as purslane, lamb's quarter, pigweed and morning-glory, furnish some protein, the average hog is in need of more bone and muscle-building material than he can get in the corn field. Some means should be provided to supply supplements to the corn crop.

Supplements Necessary

Tankage or some other supplement furnishing high quality protein equally cheaply, should be fed when hogging-down a field of corn. It seems to be far more important to feed tankage than to grow soy beans or rape with the corn. And even though a stand is obtained of the soy beans or rape, it is still advisable to use the tankage. Weaver, of the Missouri station, gives the following average results for hogging-down corn and soy beans, with and without tankage, during the years 1919, 1920 and 1921:

Hogging-down corn (courtesy of Iowa Station).

Table IX

Weight (in pounds) and Yield (in bushels)	Corn and soy beans supplemented with tankage in self-f'd'r	Corn supplemented with tankage in self-feeder.	Corn and soy beans	Corn
Hogs in lot	15	15	15.33	14.66
Days fed	22.33	23.66	22.66	26.33
Average initial weight	111.84	110.133	109.683	107.65
Average final weight	150.116	153.96	131.093	130.706
Total gain	**541.33**	**623.83**	**319.50**	**318.66**
Average daily gain per head	1.759	1.8756	1.2836	.9796
Tankage, total	207.75	280.50		
Average daily tankage per head	.6483	.7656		
Tankage per pound of gain	.3973	.4166		
Yield of corn	36.25	44.23	34.9	43.06
Yield of soy beans—seed	4.46	....	3.39	

Rape, soy beans, cowpeas (in the southern Corn Belt), pumpkins and rye are grown in the corn field for hogging-down. The value and the method of planting these crops in the corn field are discussed in Chapter 18. Hogs running in the corn field will utilize the corn to better advantage and require less tankage if they may run on a clover, alfalfa, rape or blue grass pasture adjoining the corn field.

Other Essentials

It is essential that the hogs be put on a full feed of corn before being turned into the corn field. It is a good practice to feed green corn fodder with the old corn so that the hogs will get accustomed to their new ration. The feeding of oats will help somewhat in counteracting the laxative effects of feeding the green corn. If the hogs come in at night, feed them some old corn before turning them out in the morning.

Hogs do better when an abundance of water and shade are provided. Clean, clear tile water is good if the land from which it comes is free from cholera and other contagious infection. Clear creeks of known source and fresh springs are good drinking places for hogs. The ordinary barrel water works well in most places. The value of plenty of clean, fresh water for hogs in the corn field can not be over-emphasized.

Carrying Capacity of Corn

Usually the field should be fenced, so that small areas may be harvested at a time. It is well to hog-off an area in three weeks, and better in two weeks. Spring shotes weighing 90 to 130 pounds are desirable for hogging-down corn. According to the Minnesota station, it will require the following number of days to hog off an acre of corn with 125-pound pigs:

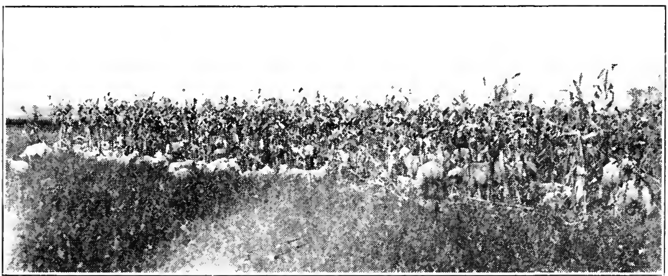
Table X

Number of Pigs Weighing 125 Pounds	Approximate No. of Days: 30-bu. per-acre corn	40-bu.-per-acre corn	50-bu. per-acre corn	60-bu.-per-acre corn	70-bu.-per-acre corn
10	22.5	30.0	37.5	45.0	52.5
20	11.2	15.0	18.7	22.5	26.2
40	5.6	7.5	9.3	11.2	14.1

Sheeping-Down Corn

The practice of turning lambs into the corn field at the rate of six or seven per acre, to clean up weeds and the lower leaves of corn, is a good one. Turning in twenty to forty lambs per acre to harvest the corn crop is more doubtful, for the reason that the lambs are ready to go back to market at the time when the fat lamb market is usually low, and, moreover, there is often some death loss when the lambs first start to eating corn.

In the latter practice, all of the essentials, such as providing proper forage, water, shelter, fencing, salt, the right kind of animals, and proper management are similar and equally as important for sheep as for hogs. It is profitable to have additional pasture and forage outside of the



Sheeping-down corn.

corn field for the lambs. Plenty of rough feed should be supplied so that the lambs will not eat too much corn. The same forages, soy beans, cowpeas or rape, as sown in the corn field for hogs, may be used for sheeping-down. At the Nebraska station, they found it advisable to feed the average lamb in the corn field one-fourth of a pound of oil meal daily.

Thrifty lambs, weighing from 45 to 60 pounds, are desirable animals for sheeping down corn. Older sheep are all right if not too de-

fective in the teeth to eat corn readily. The feeders should be started slowly on the corn to keep down scours and bloat. Extreme precaution and common sense should be used in turning the lambs into the corn field.

Lambs turned in the corn field late in September will gain from twelve to twenty pounds per head in a feeding period of from two to three months. During the feeding period the lambs will harvest one or two bushels of corn each, depending on the amount of supplementary feed. Small areas should be sheeped-down and the lambs moved before they have to hunt for feed. Shotes running with the lambs or turned in the field afterwards will clean up the corn left by the lambs.

Harvesting With Horses and Cattle

Horses and cattle may be used to harvest the corn from the standing stalks in the field. However, the disadvantages of packed soil, waste and fencing difficulties, are more pronounced than in hogging-down. This method of harvesting is not a widespread practice, and is not used except in case of very cheap corn when husking is high-priced or labor is difficult to get. It is better to husk the corn fairly clean and turn in the horses and cattle to pasture the stalks and clean up the corn remaining in the field.

CHAPTER 18

COMPANION CROPS FOR CORN

OCCASIONALLY, other crops are grown with corn to balance the corn ration for animals and to utilize the ground better. It is doubtful if the returns warrant either reason. At any rate, there are many essentials and precautions to keep in mind in order to get the most out of an acre of corn and to feed the crop profitably.

The crops ordinarily planted with corn are soy beans, rape, cowpeas (in the southern Corn Belt), and sometimes pumpkins. Clover and rye have been sown in corn just before the last cultivation of the corn, with varying success. Usually, the lack of moisture causes poor results and makes it a poor practice. The crop sown with corn should be well adapted to the locality and add more to the combination than it takes away.

Soy Beans

Soy beans are a comparatively new crop in America, especially in the Corn Belt. Trials during the last twenty years have shown the crop to have a wide range of adaptation, including all the corn and cotton lands of the country. The seeds are four times as rich in protein and fat as shelled corn.

The most popular use of soy beans in the Corn Belt is for planting with corn for hogging-down or for silage. Over 70 per cent of the soy beans grown in the Corn Belt are planted with corn for hogging-down. The beans are planted at the same time as the corn. They are erect-growing annuals which do not interfere with the growth of corn or with cultivation. The cost of cultivation is not increased by the addition of the beans, and the feeding value of the corn is improved. There is no real difficulty in handling the beans with corn for silage.

Effect of Yield on Corn

When sown at the ordinary rate of three beans with three kernels of corn per hill, most experiment stations agree that there is some reduction in yield of corn. Practical farmers, however, seem to be of one opinion, that the total feeding value of the crop is increased. The amount of the decrease in the corn yield will depend almost entirely upon the amount of moisture and plant food available for the crop. If there is sufficient of each for both crops, little decrease in the yield of corn can be noticed, but if the crop is struck by drouth, the corn will suffer before the beans.

Method of Planting

The most practical method of planting beans with corn is to place the beans in the hills of corn at the same time the corn is planted. This

is best accomplished by means of a bean attachment for the planter, which is operated by the check wire the same as the corn planter. It is also possible to drill corn and drill beans at the same time, or to check corn and drill beans between the hills. The latter method has given greater yields of both corn and beans than hills of corn and beans together, but there are disadvantages in the cultivation of such a planting. Beans and corn may be mixed and planted from the corn planter box, but this is not so satisfactory, as an uneven stand of corn often results because the beans settle to the bottom of the planter box faster than the corn. Practical farmers, by adding a handful or so of beans on top of the corn at each round, can overcome this objection to some extent.

Rate of Seeding

About three beans per hill of corn should be planted. The greater the number of beans per hill, the greater the reduction in the yield of corn.

If three beans are planted per hill, the pounds of beans required for each acre are as follows:

	Pounds
Manchu (large seed)	5.0
Medium green (large seed)	5.0
Ito San (medium seed)	3.5
Chestnut (medium seed)	3.5
Ebony (medium seed)	3.5
Midwest (medium to small seed)	3.0
Peking (small seed)	2.0

One bushel of beans, therefore, will plant from twelve to thirty acres, depending on the size of the beans.

Varieties

The several hundred varieties of soy beans are as different as are varieties of corn, and much of the success in soy bean growing depends upon the choice of the proper variety. To be planted with corn, a variety must be chosen that will ripen with the variety of corn that is used as the companion crop. For silage and sheeping-down, a later variety may be used, but for hogging-down the soy bean variety should be matured when the hogs are turned in. The early varieties, like Ito San and Chestnut, ripen readily in the most northern states. The mid-season kinds, like Peking, Manchu and Medium Green, mature in the Corn Belt.

Inoculation

Inoculation is an important factor on most Corn Belt soils. The inoculation of the seed or soil is simply applying some substance that is known to carry live bacteria. On fields that have grown a successful crop of soy beans during the past three or four years, the bacteria are usually present in sufficient numbers. On other fields, they should be supplied in order to insure maximum yields. Inoculation, however, is not absolutely necessary for the production of a crop.

There are various methods of inoculation. An easy method is to use soil from a field that has grown a successful crop of soy beans during the previous year. Dry it in a shady place and when the soil is dry enough to sieve through a piece of sereen wire, spread the seed about two or three inches deep on a clean place. Make a solution of one-half

Soy beans in corn furnish green feed rich in protein.

cup of sugar to one quart of hot water for each bushel of beans. When the solution is cool, sprinkle it over the beans to make them sticky. Sift the soil uniformly over the moist beans. After drying a few hours, the beans are ready to plant.

In case no inoculated soil is at hand, commercial cultures may be used with good results. These cultures may be purchased from any seed house. The method of application is essentially the same as the one mentioned, except that hot water must not be used. Directions for the use of commercial cultures always accompany the package and have been found to be reliable. Care should be taken not to wet the beans to such an extent that the seed coats will swell enough to break.

Rape

Rape is closely related to cabbage, turnips and rutabagas. The seed, the root system and the smooth, large, succulent leaves resemble those

of cabbage, but there is no tendency to form a head. The plant grows two feet tall under average conditions, and on rich, moist soil will grow three or more feet in height.

Rape is one of the most valuable pasture crops which can be seeded in the corn at the last cultivation, and is more valuable than soy beans in corn, if a stand can be obtained. However, because of lack of moisture, a stand of rape in corn about twice in every five years, is all that may be expected. But since rape seed rarely costs more than 13 cents a pound, and the total cost of seeding will not exceed 75 cents an acre, farmers can afford to seed rape annually with the expectancy of getting stands twice out of five years. The corn and rape growth can be harvested profitably by hogging down or by pasturing with sheep in the fall. The leafy plants also tend to shade the ground sufficiently to keep the land free of weeds. Rape has little effect on the yield of corn in the average year, reducing the corn yield about one-half bushel.

Method of Planting

The seed is generally scattered with a hand seeder at the rate of three to five pounds per acre, immediately preceding the last cultivation, which should be shallow. It may be sown a little later with a one-horse drill, but the delay in time of seeding and the additional labor are objections which probably more than offset the advantage of providing a more uniform distribution and covering of the seed. The success of late seedings depends largely on the rainfall during July and August.

Varieties

There are two types of rape, the winter or biennial and the summer or annual. The biennial kind lives two years where the winters are extremely mild, as in the South and on the Pacific coast, but in the Corn Belt the plants are killed by hard freezes in late fall, so it is necessary to make new seedings every year. The summer or annual type, which is also known as "bird-seed" rape, produces seed the first season, but the plants do not make sufficient growth to be of value for forage. The winter or biennial kind, usually known as Dwarf Essex rape, is the only one recommended for Corn Belt seeding.

Cowpeas

In the southern Corn Belt and in the South, the cowpeas make a good growth when planted with corn. The crop requires more heat than corn and is not grown to any extent north of the southern line of Iowa. Many of the things said about soy beans apply to cowpeas. However, the cowpea is a vining plant and not erect-growing like the soy bean. Cowpeas succeed on poorer soils better than soy beans. They should not be planted until the soil is thoroughly warm. Similarly to soy beans, the crop may be sown with corn in one operation with the ordinary corn planter. Broadcasted in the corn and covered at the last cultivation,

they should be sown about one bushel to the acre. If cowpeas have been grown in a locality for a long time, inoculation will not be necessary. The Whippoorwill, New Era and Iron are common varieties.

Pumpkins

According to the Iowa experiment station, pumpkins are often used to advantage with corn. The seed is planted in either missing hills or adjacent to every third hill. Corn planters are now available with a pumpkin seed attachment. On a fertile soil the pumpkins do not seriously interfere with the corn crop and are an added source of revenue, yielding from two to three tons per acre.

Many of the canning factories are ready to contract for this crop in the spring at a specified price, or it may be fed to the stock. From two to three tons per acre is a common yield, depending on the severity of injury from the bugs when the plants are small and an adequate moisture supply when the pumpkins are filling out.

Other Crops

Clovers, alfalfa and rye have been sown in corn just before the last cultivation of the crop, with varying success. Usually the lack of moisture causes poor results. It is not a widespread practice and is not recommended. Many other crops may be sown with corn, but usually to no advantage.

CHAPTER 19

FEEDING CORN TO LIVE STOCK

CORN is the basis of the live stock grain ration in the Corn Belt, for it is (1) plentiful, (2) easily obtained, (3) comparatively cheap, (4) palatable to all classes of live stock, (5) high in carbohydrates, and (6) low in crude fiber. Corn is a carbohydrate or starchy feed, rich in energy, fat and heat-forming material, but it is low in protein and ash—bone and muscle-building material. The protein which the kernel does contain is inefficient and unbalanced. About 58 per cent of the protein is zein, which lacks some of the amino acids necessary for animal growth.

Composition of Corn

The average percentage composition of some of the common carbohydrate grains, as given by Henry and Morrison, is as follows:

Table XI

Grain	Water	Ash	Crude Protein	Carbohydrates: Fiber	Carbohydrates: N. F. E.	Fat
Dent Corn No. 3	16.5	1.4	9.4	1.9	66.1	4.7
Wheat	10.2	1.9	12.4	2.2	71.2	2.1
Oats	9.2	3.5	12.4	10.9	59.6	4.4
Barley	9.3	2.7	11.5	4.6	69.8	2.1
Rye	9.4	2.0	11.8	1.8	73.2	1.8

It will be noted in Table XI that corn, wheat and rye each contain about 2 per cent fiber, whereas barley contains more than twice as much fiber as corn, and oats contain five or six times as much. In the case of hogs, each 1 per cent of excess fiber lowers the feeding value by 5 per cent. Fiber is not so important with horses and cattle, and for this reason oats are much more efficiently utilized by this class of live stock than by hogs.

The following table from "Feeds and Feeding," by Henry and Morrison, shows the average digestible nutrients and the nutritive ratio of the common grains:

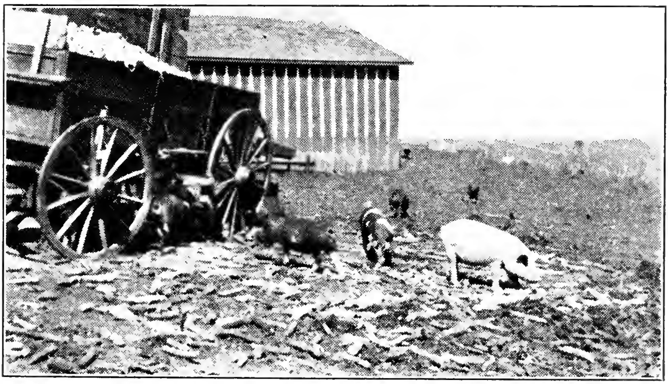
Table XII

Grain	Total dry matter	Crude protein	Carbo-hydrates	Fat	Nutritive ratio
Dent Corn No. 3	83.5	7.0	63.3	4.3	1:10.4
Wheat	89.8	9.2	67.5	1.5	1: 7.7
Rye	90.6	9.9	68.4	1.2	1: 7.2
Oats	90.8	9.7	52.1	3.8	1: 6.2
Barley	90.7	9.0	66.8	1.6	1: 7.8

Value of Corn as a Feed

Corn is the premier feed for fattening live stock. It also holds a prominent place in the rations for breeding and growing stock, but it is especially necessary with such animals to supplement the corn with feeds rich in protein and mineral matter.

In chemical composition, different colors of corn are the same. However, the feeder has always noticed that live stock prefer yellow



Half the corn of the Corn Belt is fed to hogs

corn. Experiments at the Wisconsin station indicate that yellow corn contains Vitamin A, which is lacking in white corn. Flint corn is harder than dent corn, and may be more difficult for live stock to eat. An experiment at the Illinois station indicated that hogs would eat about four pounds per day of Democrat corn (a hard corn, but not a flint); whereas, of Silvermine (a moderately hard corn) they would eat about five pounds. Moreover, the hogs required about 8 per cent less of the softer Silvermine to produce 100 pounds of gain than they did of the somewhat harder Democrat.

The following table gives the comparative values of corn and other feeds based on chemical analyses, as given in Table I of Henry and Morrison's "Feeds and Feeding," when nitrogen-free extract (starch) is valued at 1.2 cents per pound, fat at 3 cents a pound, and protein at 5 cents a pound.

Table XIII

GRAINS	Value Per Bu.
Corn, No. 3	$ .78
Oats	.47
Barley	.71
Rye	.85
Wheat	.92
Soy beans	1.60
*ROUGHAGE	Value Per Ton
Clover Hay	24.00
Timothy	18.40
Alfalfa	25.20
Oat Straw	14.80
COMMERCIAL FEEDS	
Bran	31.60
Shorts	34.00
Hominy Feed	30.80
Oil Meal (old process)	47.00
†Cottonseed meal (39 per cent)	51.40
Tankage (60 per cent)	65.80
Gluten Feed	40.40
Soy Bean Oil Meal	54.20
Corn Oil Cake Meal	40.20

Barley, wheat and rye, if they are to have a feeding value as high in relation to corn as indicated in this table, must be ground.

In years of large corn crops, it may be advisable to value the nitrogen-free extract at 1 cent a pound or even less, whereas protein may still be worth 5 cents a pound. It is necessary, therefore, to re-calculate this table if it is to fit changing conditions from year to year.

No animal can make satisfactory growth on corn alone. In the case of hogs, the bone and muscle-building material in which corn is lacking may be supplied by small amounts of tankage, oil meal, dairy by-products, pasture, or alfalfa or clover hay. With cattle and sheep, oil meal, cottonseed meal, clover hay, alfalfa hay, or pasture most commonly supply the necessary protein and mineral matter.

Importance in Feeding Operations

Eighty per cent of the corn crop is fed to live stock. In growing corn, therefore, it should constantly be kept in mind that live stock, in all probability, will be the final market. The outstanding problem of the Corn Belt is to obtain the greatest possible number of pounds of live stock from each acre of land at the least expenditure of human labor. Any step forward which results in the economic production of more bushels of corn per acre is fundamental to solving this problem.

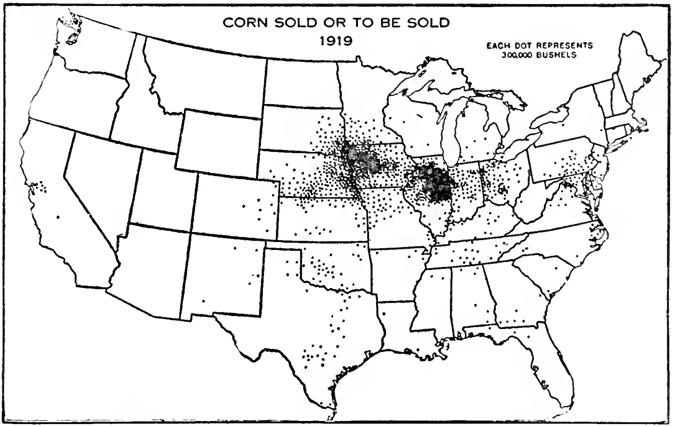
*When digestibility is taken into account, these hay values are about 15 per cent too high.

†Feeding tests indicate that cottonseed meal is worth only about 85 per cent as much as the chemical analysis value used above.

CHAPTER 20

MARKETING CORN

ABOUT 250,000,000 bushels annually, or 15 to 20 per cent of the Corn Belt production, passes through such large primary corn markets as Chicago, Omaha, Peoria, Indianapolis, St. Louis and Kansas City.



Most of the corn which comes on the terminal markets originates in central Illinois, northwestern Iowa and eastern Nebraska. (Courtesy of United States Department of Agriculture.)

Chicago is outstandingly the largest of these primary markets, normally receiving over 100,000,000 bushels annually, or as much as any other four markets put together. Northern Iowa, central Illinois and eastern Nebraska furnish over half of the corn which is received by the primary corn markets.

From Farm to Local Elevator

In north-central Iowa, the typical method of handling the corn which is eventually sold at Chicago is described in the following: The farmer hauls his corn, either shelled or on the ear, to the local elevator. Most progressive farmers who have any large quantity of corn to sell prefer to shell at home, because they can haul a larger load of shelled corn. Moreover, they have the cobs to burn, and as a rule the elevator will pay them a cent or two a bushel more for shelled corn than for ear

corn. The cost of hauling corn four or five miles is about four cents a bushel when man labor is 25 cents an hour and horse labor 13 cents an hour.

In November, December and early January, many elevators run a moisture test on the corn which they buy, especially in soft corn years. While the local elevators do not usually buy corn on grade from the farmers, it is necessary at the start of each season for them to determine about how the typical corn in their respective communities will grade. If they find, as Iowa elevators found in December of 1917, that

Hauling corn.

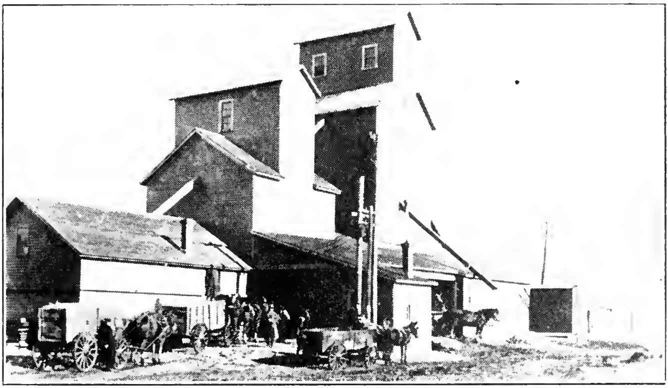
most of the corn is 22 to 26 per cent moisture, they know that it will grade either as No. 6 or Sample grade on the Chicago market. They therefore pay the farmers the Chicago price for Sample grade corn minus freight to Chicago and the cost and risk of handling.

Price Differential Between Corn on Iowa Farms and at Chicago

In the ordinary year, new corn in northern Iowa in December contains less than 19.5 per cent moisture, which permits it to grade as No. 4. As a rule, therefore, Iowa elevators during the early winter pay the Chicago price for No. 4 corn minus freight and handling charges. The freight from north-central Iowa to Chicago previous to June 25, 1918, was about seven cents a bushel. The rate was then raised until it reached 13 cents a bushel during the latter part of 1920 and during 1921. During 1922 and 1923, the rate has been 10.5 cents a bushel. It cost the ordinary country elevator about three cents a bushel to handle

corn previous to 1917, and about 4.5 cents a bushel with costs as they have prevailed during 1922 and 1923. This means that before the war the north-central Iowa elevator during the early winter usually paid the farmers for corn the Chicago price for No. 4 corn less seven cents for freight and three cents for handling. In other words, with Chicago No. 4 corn at 60 cents a bushel, the north-central Iowa elevator paid 50 cents.

In the summer-time, when the moisture content in farm corn dropped to less than 15.5 per cent and it would, therefore, grade as No. 2 instead of No. 4 on the Chicago market, the north-central Iowa elevator would pay the farmers about 10 cents below the Chicago price for No. 2 corn. During 1922 and 1923, the standard differential between Chicago corn prices and prices paid by north-central Iowa elevators has been 10.5 cents (the freight rate) plus 4.5 cents (the handling



Typical country elevator.

charge), or a total of 15 cents. At times some other market may bid more for Iowa corn than Chicago, and in such case Iowa farmers may get for their corn a price within eight cents a bushel for corn of the same grade at Chicago. This is rather unusual, however, and is a result as a rule of corn shortage in Missouri, Kansas and Texas, which causes a strong temporary movement of Iowa corn southward.

Types of Country Elevators

There are three kinds of country elevators—independent, line and farmers' co-operative. The independent elevator is usually owned by a wealthy man in a small town who has an extensive acquaintance with farmers. Bankers, lumber dealers and feed dealers seem especially likely to embark on this line of business.

The Federal Trade Commission reports that of over 9,000 concerns handling grain at country stations in 1918, from which reports were secured, 36 per cent were commercial line elevators, 19.49 per cent were farmers' co-operatives, and 31.62 per cent were commercial independents. The local mills accounted for most of the balance. In several of the grain states, where there is a keen interest in co-operative marketing, the percentage of farmers' elevators is much higher than the general average of the country as reported by the Federal Trade Commission. For instance, Iowa's percentage of co-operative elevators was estimated at 32.6 in 1921. It should be noted also that the average farmers' elevator does business on a bigger scale than either of the other types. It buys annually on the average nearly twice the volume of the line elevator and about one-half more than the average independent. Ordinarily, an elevator should handle 100,000 bushels of grain annually if it is to do business on an economical basis.

Previous to 1900, many of the line elevators profiteered unmercifully, at the expense of their farmer patrons, and did all in their power to prevent the formation of co-operative elevators. Since 1910, the different types of elevators seem to have been doing business on about the same margin, with the tendency in favor of the co-operative elevators in years of rising prices, and oftentimes in favor of the line or independent elevators in years of falling prices.

Two Ways in Which Country Elevators May Sell Grain at Chicago

Country elevators may ship their grain to Chicago as fast as they are able to fill the cars, or they may ship a little more leisurely and protect themselves against a decline in the market by "hedging" (selling short as many bushels of corn for future delivery as they have bought from the farmers). If the elevator does not take out any price insurance in the form of "hedge" sales, it will make a speculative profit above expectations in case the Chicago market advances before the car gets to it. On the other hand, there may be a speculative loss if the market falls. This speculative risk becomes very great in years of car shortage, which may cause the lapse of several weeks between the time the corn is purchased from the farmer and the time it is sold at Chicago.

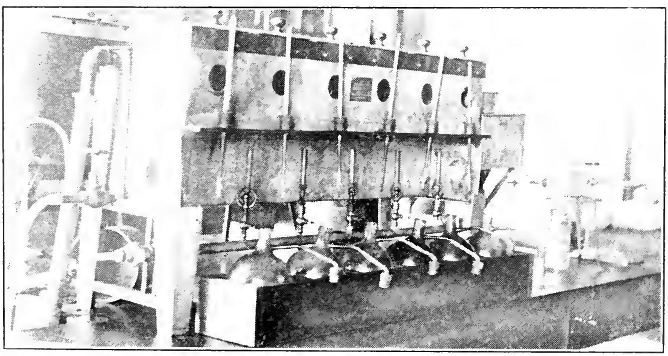
When an elevator deals only in cash grain without any "hedge" insurance, it is necessary to pay about \$2 a car (about one-seventh of a cent per bushel) for brokerage and miscellaneous charges. If, however, an elevator takes out "hedge" insurance by selling "future" corn at the time the purchase is made from the farmers, it is necessary to pay about one-fourth of a cent per bushel in addition for the insurance.

The method of hedging is illustrated in the following: An elevator is buying corn on February 20, which it expects to ship sometime in March. May future corn, which is the nearest future, is quoted at 72 cents and the cash No. 3 corn is 66 cents. The elevator knows it must buy corn from farmers at 15 cents below Chicago price for same grade,

and it therefore pays 51 cents for 1,115 bushels of corn, which is all that is offered to it that day. The same day it wires a commission company at Chicago to sell 1,000 bushels of May corn at 72 cents (the 6-cent difference between the February cash No. 3 corn price and the May future is in part caused by contract future corn being No. 2 and in part by the two or three months' storage charges). When the corn is finally received in Chicago, on March 10, the price of the May future may be 65 cents and the cash No. 3 corn 59 cents. In that case, the elevator in buying back its paper contract on March 10, makes a profit of seven cents a bushel, which enables it to meet the loss on the cash corn. On the other hand, an advance to 80 cents for May future and 74 cents for No. 3 cash will result in a loss of eight cents a bushel on the paper corn, which counteracts the gain of eight cents on the actual corn. In either case, the net result is that the elevator gets for its corn a price about equivalent to what it paid the farmers on February 20.

The theory of "hedging" is beautiful, and the practice is fairly good. Unfortunately, some elevator managers succumb to the temptation to buy and sell paper grain above what is needed for purely "hedging" purposes. In a few cases, also, the cash grain and future grain markets do not maintain the sympathetic relation toward each other which is necessary if "hedging" is to be perfect price insurance.

The four futures commonly dealt with on the Chicago market are May, July, September and December. The smallest unit of paper grain customarily handled is 1,000 bushels. Commission firms charge one-fourth of a cent per bushel, or $2.50 for 1,000 bushels, for the sale and purchase. In addition, it is necessary to put up with commission firms 10 cents a bushel, or $100 for 1,000 bushels, to serve as margin to protect the commission company in case the corn goes down before the deal



Moisture tester used in determining corn grades, both by country elevators and at primary markets.

is closed. "Hedging" can be made really useful by elevator managers, especially when they are unable to ship promptly, and the tendency of the market seems downward. In the case of line elevators, "hedging" is usually taken care of from a central office. Many co-operatives do not hedge at all, partly because they fear their managers may speculate on the side and partly because they do not understand the advantages.

The Grain Act, which was passed by Congress in 1922, gives the United States Department of Agriculture power to designate certain markets as contract markets where futures may be traded in. Regulations may also be prescribed with the idea of making it possible for the future grain prices to register actual changes in supply and demand conditions rather than mere speculative raids and corners. It is to be assumed, therefore, that the Grain Act may make it possible to use the Chicago market for "hedging" purposes with greater safety than would otherwise be the case.

Handling Cash Grain at Chicago

Grain cars, when they reach Chicago, are switched onto grain tracks, where they are examined by state grain inspectors. Samples of grain are taken from each car, and these samples are taken to a grain grading room, where the percentage of moisture is ascertained and the corn is given a definite grade on the basis of the Federal Shelled Corn Standards, as set forth in the following:

Table XIV—Grade Requirements for White, Yellow and Mixed Corn

Grade	Minimum test weight per bushel (lbs.)	Maximum Limits of: Moisture (per cent)	Foreign material and cracked corn (per cent)	Total damaged corn (per cent)	Heat damaged corn (per cent)
No. 1	55	14.0	2	2	.0
No. 2	53	15.5	3	4	.1
No. 3	51	17.5	4	6	.3
No. 4	49	19.5	5	8	.5
No. 5	47	21.5	6	10	1.0
No. 6	44	23.0	7	15	3.0
Sample					

Sample grade shall be white corn, or yellow corn, or mixed corn, respectively, which does not come within the requirements of any of the grades from No. 1 to No. 6, inclusive, or which has any commercially objectionable foreign odor, or is heating, hot, infested with live weevils or other insects injurious to stored grain, or is otherwise of distinctly low quality.

The corn in Grades Nos. 1 to 5, inclusive, shall be cool and sweet.

The corn in Grade No. 6 shall be cool, but may be musty or sour.

Definitions

For the purposes of the official grain standards of the United States for shelled corn (maize):

Corn—Corn shall be shelled corn of the flint or dent varieties.

Basis of Determinations—Each determination of color, damage and heat damage shall be upon the basis of the grain after the removal of foreign material and cracked corn as provided in the section defining foreign material and cracked corn. All other determinations shall be upon the basis of the grain, including such foreign material and cracked corn.

Percentages—Percentages, except in the case of moisture, shall be percentages ascertained by weight.

Percentage of Moisture—Percentage of moisture in corn shall be ascertained by the moisture tester and the method of use thereof described in Circular No. 72 and supplement thereto, issued by the United States Department of Agriculture, Bureau of Plant Industry, or ascertained by any device and method giving equivalent results.

Test Weight Per Bushel—Test weight per bushel shall be the weight per Winchester bushel as determined by the testing apparatus and the method of use thereof described in Bulletin No. 472, dated October 30, 1916, issued by the United States Department of Agriculture, or as determined by any device and method giving equivalent results.

Foreign Material and Cracked Corn—Foreign material and cracked corn shall be kernels and pieces of kernels of corn, and all matter other than corn, which will pass through a metal sieve perforated with round holes twelve sixty-fourths of an inch in diameter, and all matter other than corn remaining on such sieve after screening.

Heat-Damaged Kernels—Heat-damaged kernels shall be kernels and pieces of kernels of corn which have been distinctly discolored by external heat or as a result of heating caused by fermentation.

The market corn is also divided into classes on the basis of color, as follows:

White Corn—This class shall consist of corn of which at least 98 per cent by weight of the kernels are white. A slight tinge of light straw color or of pink on kernels of corn otherwise white shall not affect their classification as white corn.

Yellow Corn—This class shall consist of corn of which at least 95 per cent by weight of the kernels are yellow. A slight tinge of red on kernels of corn otherwise yellow shall not affect their classification as yellow corn.

Mixed Corn—This class shall consist of corn of various colors not coming within the limits for color as provided in the definitions of white corn and yellow corn. White-capped yellow kernels shall be classified as mixed corn.

In the ordinary crop year, the leading primary markets receive about equal amounts of No. 2, No. 3 and No. 4 grades of corn, with much more No. 3 and No. 4 corn coming in during December and January. In a soft corn year like 1917, 25 to 40 per cent of the corn may be soft corn and sell 5 to 15 cents a bushel below No. 2. In unusually sound corn years like 1920, half of the corn may grade as No. 2 or better.

CHAPTER 21

CORN PRICES

CORN prices are chiefly dependent on the size of the crop in the United States. Statistical research indicates that corn prices before the war, on farms of the United States, on December 1, varied up and down according to size of the crop, about as follows:

Corn Crop	Price, Dec. 1, on farms
20 per cent below normal	34 per cent above normal
15 per cent below normal	21 per cent above normal
10 per cent below normal	15 per cent above normal
10 per cent above normal	8 per cent below normal

The normal corn crop for the United States from 1923 to 1928 seems to be about 2,850,000,000 bushels. Because of world-wide price disturbances, it is exceedingly difficult to say just what will be the normal corn price on farms of the United States on December 1, from 1923 to 1928. If we assume 80 cents as the normal corn price, a crop of 3,135,000,000 bushels (10 per cent above normal) would mean, according to the table, a price of 8 per cent below normal, or 73.6 cents, whereas, a crop of 2,565,000,000 (10 per cent below normal) would indicate a price of 15 per cent above normal, or 92 cents.

Corn Prices Also Influenced by Size of Crop Two Years Previous

A large corn crop two years previous tends to mean higher corn prices this year. This is probably a result of a larger hog population which followed the large corn crop and which is still existing two years following the large corn crop. This influence is very small as compared to the influence of the size of the corn crop the same year. The tendency is expressed in the following:

Corn Crop, two years previous	Price, Dec. 1, on farms
25 per cent below normal	5 per cent below normal
10 per cent below normal	2 per cent below normal
10 per cent above normal	2 per cent above normal
15 per cent above normal	3 per cent above normal

Corn Prices Influenced by Wheat Prices

Both corn flour and corn meal are used occasionally to some extent as wheat flour substitutes, and there is therefore a little sympathy between wheat and corn prices. Before the war, this relationship seems to have been about as follows:

Wheat Price Dec. 1, on farms	Corn Price Dec. 1, on farms
30 per cent below normal	6 per cent below normal
20 per cent below normal	4 per cent below normal
10 per cent below normal	2 per cent below normal
10 per cent above normal	2 per cent above normal
20 per cent above normal	4 per cent above normal
30 per cent above normal	6 per cent above normal

During the twenty years following the Civil war, corn sold on the average for only about half as much per bushel as wheat, but since 1890 corn has averaged 65 to 70 per cent as much as wheat, and in years of short corn crops and fairly good wheat crops corn has sold within a few cents a bushel of wheat. Because of the fact that wheat is richer in gluten than corn, and therefore better adapted to bread making; because a bushel of wheat weighs 60 pounds, whereas a bushel of corn weighs only 56 pounds, and because corn is higher in moisture than wheat, it is doubtful if corn will ever sell for any length of time for more than 85 per cent as much per bushel as wheat. It is probable, however, that corn will gradually advance from its present ratio of around 70 per cent to 80 per cent for the reason that the good corn lands of the world are much more limited than the wheat lands, and corn is used in making many more different kinds of food and industrial products than wheat. In fact, it is possible though hardly probable that corn will eventually sell for practically the same price per bushel as wheat.

For the immediate future it is to be expected in years when both the wheat and corn crops are normal, that corn will sell for about 70 per cent as much per bushel as wheat. If corn sells for a period of years above this ratio, there will be a tendency in large parts of Missouri, Illinois, Indiana and Ohio to put much land which is now in winter wheat into corn.

Corn Price in Early Winter Influenced by Hog Packing the Preceding Summer

There is a tendency for the number of hogs packed the preceding summer to influence corn prices in the early winter, about as follows:

Number of Hogs packed at western points preceding summer.	Corn Price during early winter immediately following.
8 per cent decrease below normal	4 per cent decrease below normal
4 per cent decrease below normal	2 per cent decrease below normal
4 per cent increase above normal	2 per cent increase above normal
8 per cent increase above normal	4 per cent increase above normal

Evidently, a large number of hogs fed out during the summer immediately preceding the new corn crop helps in some measure to create a situation making for slightly higher priced corn.

The average weight of hogs during the summer also indicates a little something concerning the oncoming corn price situation. The relation seems to be about as follows:

Weight of Hogs at western packing points preceding summer.	Corn Prices during early winter immediately following.
6 per cent increase above normal....	8 per cent decrease below normal
3 per cent increase above normal....	4 per cent decrease below normal
3 per cent decrease below normal....	4 per cent increase above normal
6 per cent decrease below normal....	8 per cent increase above normal

It seems that hogs are fed out to a heavier weight than usual during the summer when corn is more abundant and cheaper than usual. This indicates a temporary weakness in the corn situation which is likely to carry over to some extent into the new crop season. Fewer hogs than usual, fed to heavier weights than usual during the summer season immediately preceding the new corn crop, indicate that the hog background to corn prices is unfavorable. On the other hand, large numbers of hogs fed out to a light weight during the summer months indicate that the hog background to corn prices is favorable. Some people think that large numbers of hogs fed to heavy weights would be more favorable to high corn prices than large numbers fed to light weights. Actually, it does not work out this way, for the reason that farmers will not feed hogs to heavy weights except when there is an abundance of cheap corn, a situation which usually continues to make somewhat for cheaper corn prices during the new crop season.

Corn Prices and Hog Prices

Corn and hog ratios are discussed in the following chapter (22). There is not the close immediate connection between corn prices and hog prices that many people think. Statistical research indicates that before the war corn prices usually led the way and hog prices followed behind. As a rule, scarce, high-priced corn was followed several months later by higher-priced hogs, the full effect being felt on the hogs about eight or nine months later, and continuing for about twenty months after the short corn crop was harvested.

Hog prices are practically valueless in predicting the future course of corn prices, although corn prices may be of very real value in predicting the future course of hog prices.

Weather and Corn Prices

Since the size of the crop (discussed in the first paragraph of this chapter) has far more to do with corn prices than all the other factors put together, it is especially important to study the weather in its relation to the size of the crop. This is gone into in great detail in Chapter 3. Suffice it to say here that the all-important weather from the standpoint of corn prices is the rainfall and temperature from July 1 to August 20. During this period, it requires an average of about one inch of rainfall every ten days to hold new crop futures (December and May) corn prices steady. More than one inch of rainfall in ten days tends to lower corn prices, 1.4 inches or more tending to cause a drop of two or three cents a bushel. Less than half an inch of rainfall in

ten days tends to cause an advance of three or four cents a bushel. If there has been an average of less than a tenth of an inch of rain during the ten-day period, and if the mean temperature has averaged above 80 degrees, the corn price may run up six to eight cents a bushel. To determine the average rainfall, it is necessary to have reports from at least twenty representative stations in each of such states as Iowa, Illinois, Indiana, Ohio, Missouri, Nebraska and Kansas. The daily corn and wheat region bulletin, which may be obtained from the Chicago Weather Bureau, gives such information.

Prices as Influenced by Shrinkage and Time of Year

Illinois and Iowa experiments indicate that on the average, corn picked early in November will shrink about 3 per cent during November, 2 per cent during December, 1 per cent in January, 1 per cent in February, 1 per cent in March, 3 per cent in April, 3 per cent in May, 2 per cent in June, and 1 per cent in July, normally making a total of about 17 per cent shrinkage from cribbing time in November until the middle of the following summer. Of course, there is considerable variation in the years. If the fall is dry and the corn is unusually well matured, the shrinkage may amount to only 9 or 10 per cent, whereas in years when the fall is wet or the corn is poorly matured, it may run as high as 25 per cent. The monthly figures represent normal conditions. In some years, however, the really heavy shrinkage will start in late March, in other years in April, and occasionally not until June. Ordinarily, though, late April and May is the time of the heaviest shrinkage in corn, much depending, however, on the temperature and the humidity.

On the basis of shrinkage alone, it would take, to equal a price of 50 cents a bushel for corn in November, 55 cents in April and 58 cents in July. When interest is added at 6 per cent, and allowance is made for the overhead investment in the crib, and for a small amount of rattage, it will be found that in the ordinary year, it will take, to equal a price of 50 cents a bushel for corn in November, about 52 cents in December, 53 cents in January, 54 cents in February, 55 cents in March, 57 cents in April, 59 cents in May, 60 cents in June, 62 cents in July, and 62.5 cents in August. The actual pre-war normal price for corn on Iowa farms was 49 cents a bushel in late November and December, 50 cents in January, 51 cents in February, 53 cents in March, 56 cents in April, 59 cents in May, 61 cents in June, 63 cents in July, 63 cents in August, and 61 cents in September. This would indicate that before the war, it was normally a good plan to sell corn in late November, if possible, rather than to sell in December, January, February or March. Rather than to sell in these months, it seemed usually to be a good plan to hold for a June, July or August market.

Corn Prices as Affected by the General Price Level

Whenever the general price level rises as a result of the abundant currency which follows upon an increased gold supply, improved bank-

ing methods, or war, it is inevitable that corn prices also should rise. From 1896 to 1913, the general tendency of corn prices was upward, because prices of all kinds were going up as a result of the sudden increase in gold output accompanied by improved banking methods. From 1915 to 1920, the war demand, accompanied by currency inflation, sent prices of all kinds up, and corn moved in sympathy.

From 1896 to 1913, food prices of most kinds increased somewhat more rapidly than prices generally, because the great over-production of food resulting from the opening of the Mississippi valley was finally absorbed. Corn prices advanced more rapidly than most other food prices, because the corn land of the world was quite fully exploited before the wheat, oat and rye land.

If we express the relation between farm corn prices and the general United States price level as 100, in the decade 1906-1915, then the relation during the twenty years extending from 1866 to 1885 was 79, whereas the relationship during the decade of 1886-1895 was 88 and during the decade of 1896-1905 the relationship was 87.

Using the same method, we find the corn crops of 1920, 1921 and 1922 selling for an average of only 61, as compared with 100 in 1906-1915. This very low relationship was caused partly by the inability of Europe to pay normal prices for our surplus corn and pork products and partly by the ability of organized labor and organized business to hold up manufactured products and freight rates to a high level. Corn prices will doubtless reach again their 1906-1915 ratio to the general price level by the decade of 1930-1940. The decade of 1920-1930 is one of readjustment and uncertainty.

Corn Prices and Wages of City Labor

From 1841 to 1860, a bushel of corn on the Chicago market sold for the value of four hours of city labor. From 1873 to 1902, a bushel sold for the value of 2.3 hours. From 1903 to 1912, a bushel sold for the value of 2.4 hours of labor. Corn in 1921 and 1922 sold on the basis of 1.2 hours of labor per bushel.

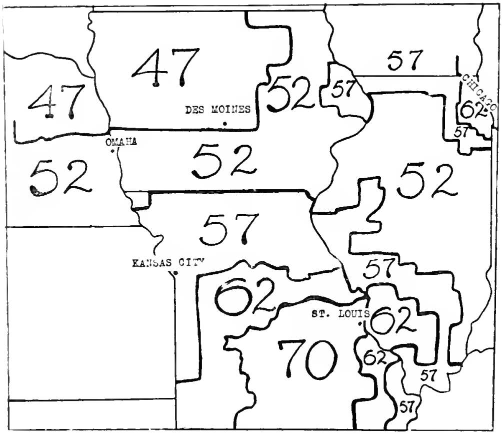
During the four years before the war (1911-1914), it required about 1,170 bushels of Chicago corn to equal the yearly wages of the railroad man. In 1921 and 1922, it required 2,700 bushels to equal the yearly wages of the railroad man.

Theoretically, it is to be assumed that in the long run the volume of city labor will increase more rapidly than the output of corn, and that therefore the tendency will be for the yearly wages of city labor to buy fewer and fewer bushels of corn. Labor-saving inventions both on the farm and in the cities tend to postpone this eventual outcome. Temporarily also, labor organizations can hold wages above the ratio with corn prices justified by the fundamental economic situation. This results oftentimes, however, in larger numbers of corn farmers looking for work in the cities. It is to be expected, therefore, that the situation

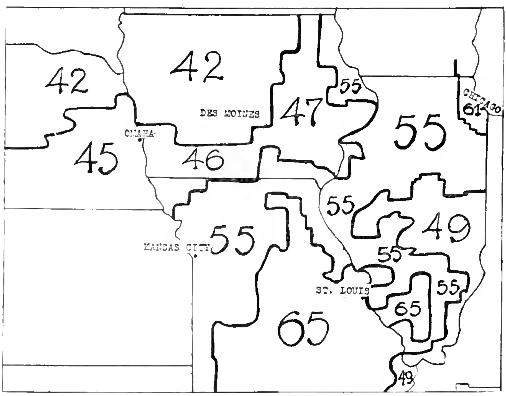
of 1921-1922 will not continue indefinitely, but that corn prices will after a time come to have as favorable a ratio with the wages of labor as in 1911-1914.

Geography of Corn Prices

Before the war, the United States Department of Agriculture made a geographical study of corn prices for the five-year period, 1910-1914. The outstanding feature of this investigation was that the center of



Geography of corn prices, 1910-1914.



Geography of corn prices, 1920-1922. Note that the cheap corn section is still about the same as before the war.

cheap corn was in northwestern Iowa, northeastern Nebraska, southeastern South Dakota and southwestern Minnesota. When No. 2 corn was 61 cents a bushel on the Chicago market during December, it was customary for corn on farms in northwestern Iowa to sell about 14 cents a bushel cheaper, or around 47 cents a bushel. Eastward and southeastward of the cheap corn section in northwestern Iowa, corn prices before the war ordinarily tended upward at the rate of about three cents every hundred miles.

A study based on the three-year period, 1920-1922, indicates that northwestern Iowa, northeastern Nebraska, southeastern South Dakota and southwestern Minnesota is still the cheap corn section. The really great difference between the two maps is caused by the increase in freight rates. During 1920 and 1921, the cost of shipping a bushel of corn from northwestern Iowa to Chicago was seven or eight cents more than before the war, and in 1922, after the reduction was made, the cost was still about four cents a bushel more than before the war.

From the standpoint of producing surplus corn for the Chicago market, the only region which compares with northwestern Iowa is central Illinois. The corn price in this section would be just as low as in northwestern Iowa except for the fact that it is two hundred miles closer to Chicago. Before the war, this gave it an advantage of five cents a bushel. Since the war, as a result of the increase in freight rates, the advantage has amounted to at least seven or eight cents a bushel.

In southern Missouri and southern Illinois, with the exception of a very small area along the river in extreme southeastern Missouri, there is no surplus corn whatever to ship to market. Home-grown live stock furnishes the market, and the corn price customarily is almost as high as the Chicago price. In fact, there are sections of the Ozarks where corn almost invariably sells higher than at Chicago. There are parts even of northern Missouri where corn is often shipped in. During 1921 and 1922, for instance, there were sections of northern Missouri with the corn price averaging around 65 cents at a time when only 200 miles away, in central Iowa, the price was 42 cents. This situation encouraged a considerable movement of Iowa corn southward instead of to Chicago.

In studying the two maps, keep in mind that the prices are based on December 1 farm values. During the summer-time, when there is less moisture in the corn, and when a corn shortage develops in many localities, farm corn prices much more nearly approach the Chicago corn prices.

For the ten years, 1913-1922, average December 1 corn prices for representative states in different sections of the country were: South Dakota, 70 cents; Iowa, 73 cents; Illinois, 78 cents; Ohio, 83 cents; Pennsylvania, 99 cents; New York, \$1.16; Massachusetts, \$1.22; Georgia, \$1.08; Texas, \$1; Colorado, 85 cents; Idaho, \$1.04, and California, \$1.24.

The corn price rises rapidly in every direction from the center of cheapest corn, where Iowa, Nebraska, South Dakota and Minnesota come together.

Corn Value

The ultimate value of corn is as a source of fuel or power. A bushel of ear corn contains about the same number of B. T. units as 50 to 60 pounds of ordinary soft coal. When soft coal is above $15 a ton and corn is less than 30 cents a bushel, corn may derive a part of its value from its heating content. This situation is reached only in communities remote from coal mines and terminal markets in years when the general economic situation is demoralized and the corn crop is very large.

When crude oil becomes so scarce that crude oil sells wholesale above 50 cents a gallon, it is possible that alcohol made from corn at 75 cents a bushel can compete with the gasoline as a source of power for automobiles and trucks.

Under ordinary conditions, corn derives its value largely from its ability to furnish fat-forming material to hogs more cheaply than any other grain. By means of the corn-hog combination, it is possible to produce palatable meat with a less expenditure of land and human labor than in any other way. Corn is the most efficient plant of the temperate zones in fixing the energy of the sun's rays, and the hog is the most efficient meat animal for converting that sun energy of corn into a palatable form for human consumption. Corn also derives a part of its value from its ability to furnish the 22,000,000 farm work horses and mules of the United States the cheapest energy which can be obtained in any grain.

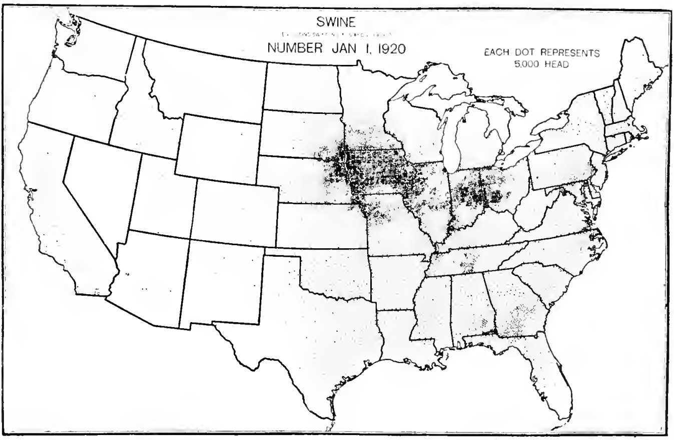
Heretofore, corn has derived only a small part of its value from its use in factories and mills. Its use in this way is steadily growing, however, and eventually the corn food products as manufactured will have as much to do with corn values as the ham, bacon and lard which are made by the hog out of corn. Commercial corn products are discussed in Chapter 37.

CHAPTER 22

CORN-HOG RATIOS

CORN and hogs influence each other profoundly. One year with another, hogs consume about 40 per cent of the corn crop of the United States, or as much as all of the other farm animals put together. Hogs are even more important as a market for corn than the foregoing indicates, for the reason that the horse, mule and dairy cow demand for corn is almost constant, whereas the hog consumption of corn often varies by as much as 10 per cent from one year to the next. Moreover, the 20 per cent of the corn crop which the farmers of the United States customarily feed to their horses and mules is used to keep the farm manufacturing plant running and is not a direct source of income. The corn which is sold in the form of hogs bulks far larger than the corn which is used in any other way.

MAP NO. VII



Note that the hog dots are thickest where corn dots are thickest, the most outstanding exception being east-central Illinois. (Courtesy of United States Department of Agriculture.)

Close Relationship

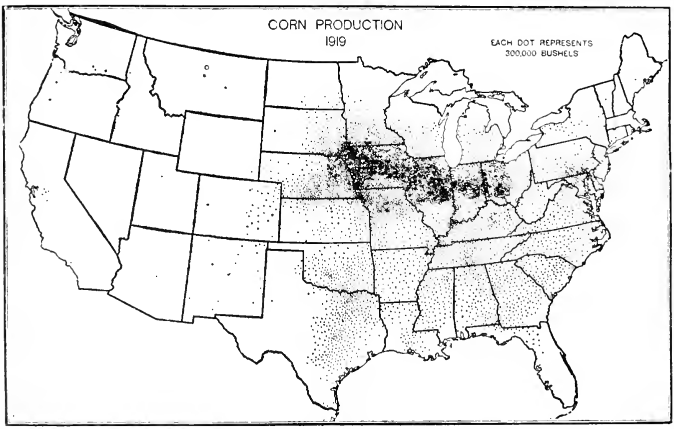
Maps Nos. VII and VIII illustrate the exceedingly close relationship between corn and hogs in the United States. It will be noticed that where the corn dots are thickest, so also are the hog dots. The outstand-

ing exception is in central Illinois, where with Chicago only 100 miles away, the comparative freight rates on corn and hogs are such as to make it more profitable on many of the rented farms to ship corn rather than hogs to Chicago. In the mountain and Pacific coast states, the hog dots are thicker than the corn dots, the hogs being fattened on barley and milo. These western hogs are barely sufficient to supply the home demand, and do not have commercial significance in the same way as the hogs of the Corn Belt.

Chicago Values as a Basis for Ratios

With corn and hogs so dependent on each other, it is not surprising that there should be a close relationship between corn and hog prices. This relationship is known as the corn-hog ratio. As the average of the past fifty years, it has required on the Chicago market 11.5 bushels of No. 2 corn to equal in value 100 pounds of heavy hogs. In other words, with No. 2 corn at 50 cents a bushel at Chicago, the tendency has been

MAP NO. VIII



Compare with Map VII and note the tendency for corn and hogs to go together in the United States. (Courtesy of U. S. Dept. of Agriculture.)

for heavy hogs to sell for 11.5 times as much, or for $5.75 a hundredweight. Decade after decade, the ratio has averaged around 11 or 12 bushels on the Chicago market. Sometimes corn is so cheap and hogs are so high that the ratio may be 15 or 16 bushels for a year or so, but in such a case the result is the breeding of so many sows that there is an over-production of hogs and a shortage of corn (unless the weather is unusually favorable), with the result that hogs become cheap and corn high and the ratio narrows suddenly to 10 bushels or even less. Usually,

hogs sell for about twenty months below their long-time ratio with corn and then for about twenty months above it. Sometimes cholera, unusual business conditions, war, or exceptional weather modifies the swing of hog prices above and below their normal ratio, but even so the swings are only rarely shorter than twelve months or longer than thirty months. The chart illustrates the rhythmical nature of the corn-hog relationship. The zero line in this chart is the 11.5-bushel ratio corrected for the season of year (in December the ratio is about 11 bushels, whereas in the early spring it averages 12.4 under a situation where the average for the entire year is 11.5 bushels).

Ratio Based on Farm Values

If Corn Belt farm values are taken for both corn and hogs, instead of Chicago values, the normal ratio is 13 bushels of farm corn to equal 100 pounds of farm hog, instead of 11.5 bushels. This difference is

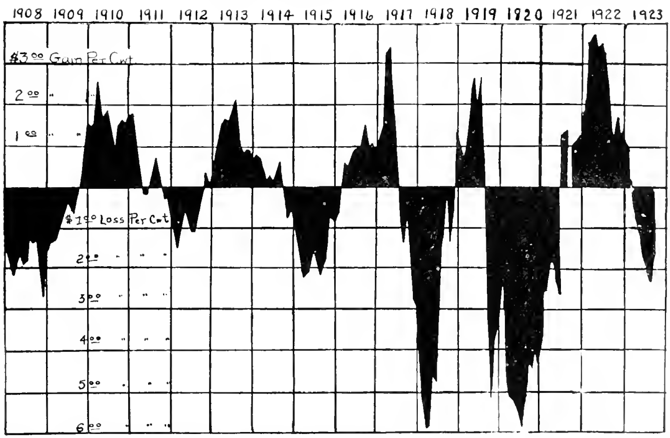


Chart illustrating when hog prices have been above and below their normal ratio with corn prices weighted seasonally.

caused partly by the fact that farm corn is on the ear instead of shelled, and averages No. 3 grade instead of No. 2. Moreover, the freight rate on corn is a much higher percentage of its value than is the case with hogs, and this automatically tends to make the ratio higher on the farm than at Chicago. The Corn Belt farm ratio between corn and hogs has a normal seasonal range from about 11 bushels during the late summer to 14 bushels in the early spring. In central Illinois, 100 miles south of Chicago, the corn-hog ratio, as a result of the freight rate situation, averages about 12.5 bushels over the same series of years that the ratio in northwestern Iowa is 13.5 bushels. The difference of one bushel in

ratios explains why it is that northwestern Iowa farmers feed on the average 45 per cent of their corn to hogs, whereas central Illinois farmers feed only 25 to 30 per cent. Over any period of time, the corn-hog ratio is a very delicate governor of the percentage of the corn crop which will be fed to hogs.

In the long run, the price which the consumers of the United States, England and Germany are willing to pay for pork and lard has more to do with determining corn prices than any other one thing. Corn farmers, even those who keep no hogs, should watch the hog market. If hogs are plentiful and low priced, it may mean a temporary scarcity of corn and high corn prices, but it also means that fewer sows will be bred for next year and that eventually a hog shortage will result, which means a corn surplus, unless unfavorable weather has caused a short corn crop at the same time as the short hog crop. Corn men should also be vitally interested in pork exports, for it is a matter of history that after several years of unusually heavy pork exports the tendency is toward an increase in corn prices. We normally export twice as much corn in the form of pork as in the form of grain. The corn-hog relationships are not as direct and immediate as many people think, but over any period of time it is astonishing how corn prices depend on hog prices, and vice versa.

CHAPTER 23

COST OF CORN PRODUCTION

IN THE best corn sections of Iowa and central Illinois, where gang plows are used and five-horse teams, an acre of corn requires about 16 hours of man labor and 42 hours of horse labor. This divides up roughly as follows: Plowing, two hours of man labor and ten hours of horse labor; disking and harrowing, two hours of man labor and eight hours of horse labor; planting, three-fourths of an hour of man labor and one and one-half hours of horse labor; cultivation, five hours of man labor and ten hours of horse labor; husking from standing stalks, five hours of man labor and ten hours of horse labor; spreading manure, one and one-fourth hours of man labor and two and one-half hours of horse labor.

Costs Vary in Different Sections

In large parts of Nebraska, where the land is very level and the fields are large, and where plowing and planting are done at the same time by means of the lister, an acre of corn requires only about fourteen hours of man labor and thirty-eight hours of horse labor. In Indiana, however, where the fields are smaller, and where the combination of heavy spring rains and a clay soil make plowing and disking more difficult, an acre of corn husked from the standing stalks may require as much as twenty-four hours of man labor and fifty-eight hours of horse labor. In the eastern part of the Corn Belt, because of the smaller fields and smaller farms, they do not use gang plows and five-horse teams as generally as in the western part of the Corn Belt. In their husking operations, also, they tend to cling to the old-fashioned husking peg instead of adopting the somewhat more speedy husking hook.

Share Tenant's Cost of Production

The cost to the share tenant of producing an acre of corn in the central part of the corn belt is the value of the man labor plus the cost of the horse labor plus the cost of the machinery. With single men getting \$51 a month and board, it may roughly be figured that the cost of an hour of man labor is around 34 cents. The cost of an hour of horse labor is roughly equivalent to the value of one-tenth of a bushel of oats plus one-tenth of a bushel of corn plus five pounds of hay, or with corn at 70 cents a bushel, oats at 40 cents a bushel and hay at \$16 a ton, it may be said that the cost of an hour of horse labor would be around 15 cents. With values as just stated, a share tenant in the central part of the Corn Belt would invest in his acre of corn about sixteen hours

of man labor at 34 cents an hour, or $5.44, and forty-two hours of horse labor at 15 cents an hour, or $6.30, making a total cost of $11.74 an acre for man and horse labor.

The machinery and miscellaneous item charge amounts roughly to two per cent of the value of a gang plow plus the value of a corn cultivator plus the value of a 20-foot harrow. Before the war, this amounted to about $2 an acre, during the war to about $4 an acre, and since the war to about $3.40.

Adding $3.40 to the $11.74, we get $15.14 as the total cost to the share tenant of producing an acre of corn when single men are getting $51 a month and board, and when horses are eating corn worth 70 cents a bushel, oats worth 40 cents a bushel and hay worth $16 a ton. In return for his investment of $15.14, the share tenant gets half the corn crop. If the yield is 40 bushels an acre, as is customary in the best parts of the Corn Belt where this method of renting is most commonly met with, the cost of producing a bushel of corn, so far as the share tenant is concerned, is $15.14 divided by 20, or 75.7 cents. With a 30-bushel crop, the cost to the share tenant would be $1.01, and with a 60-bushel crop, 50.5 cents a bushel.

This would be on the assumption that there is no more labor involved in the large crop than in the small crop. As a matter of fact. the husking charge varies directly with the size of the crop, and taking this into account, the cost to the share tenant of a 30-bushel yield of corn would be only 97.5 cents instead of $1.01, and of the 60-bushel yield, 54.5 cents instead of 50.5 cents.

Owner's Cost of Production

The farmer who owns his land has all the expenses of the share tenant plus the taxes and the interest on the investment in his land. If he paid $170 an acre for his land, he has, at five per cent, an interest charge of $8.50 an acre, and in addition there is probably a tax of at least $1.50 an acre, making a total of $10 an acre. Ten dollars plus the $15.14 which represents the man labor, horse labor and machinery charge, gives a total of $25.14. With a yield of forty bushels per acre, the cost per bushel would be 62.8 cents.

This represents the cost of the corn in the crib in December, and makes no allowance for shrinkage. If the corn is to be held until the following summer, the shrinkage, which on the average amounts to about 16 per cent, plus the interest on the value of the corn, will raise the cost by about 13 cents a bushel, or to a total of about 76 cents. If the corn is then to be shelled and hauled to market, there will be an additional cost amounting to at least four or five cents a bushel.

Reducing Costs

There is no easy way of reducing corn production costs. In sections where the fields are large and level, production costs can generally be reduced several cents a bushel if gang plows are substituted for sulky

plows and two-row cultivators for the ordinary single-row. In some sections it may be possible to reduce costs slightly by substituting tractor plowing for horse plowing. Some of the tractor people who use the tractor for corn cultivating as well as plowing, disking, harrowing and planting, have carried an acre of corn up to husking time with the expenditure of only five hours of man labor and five hours of tractor labor. This contrasts with 9.75 hours of man labor and 29.5 hours of horse labor for doing the same work in the ordinary way. Of course, the tractor was used with a two-row cultivator and the job of cultivating the first time over may not have been quite as good as with the single-row, horse-drawn cultivator. The tractor is worth while watching, however, as a possible means of reducing labor costs on large, level farms.

As a rule, however, the methods commonly used in a locality are so well adapted to the situation that it is impossible to make any change in the machinery which will result in a saving of more than a cent or two per bushel.

Land owning farmers can reduce production costs most effectively by rotating crops and applying manure. Improving the productive capacity of the soil by ten bushels per acre will ordinarily do more than anything else to reduce production costs.

One of the simplest ways of lowering corn production costs is to use the highest yielding variety possible. In every locality there are farmers growing varieties which yield five or ten bushels per acre less than the better sorts would yield on the same land. Every two or three years it is good practice to buy a few pecks of seed corn which has a reputation for high yielding power in order to compare it side by side with the home corn.

Another possible way of reducing costs is to save five hours of man labor and ten hours of horse labor per acre by using hogs to do the harvesting. With man labor at 34 cents an hour and horse labor at 15 cents, this will reduce the cost per acre by about $3.20, or, roughly, eight cents a bushel. However, hogs during late September, October and November can utilize only a limited acreage to the best advantage in this way. In wet falls, unfortunately, the hogs waste considerable corn. See Chapter 17 for further discussion.

When corn husking machines are further perfected, and especially when varieties are developed which are adapted to the corn husking machine, it may be possible by making an investment of several hundred dollars in a husking machine to save much of the man labor required in husking.

Cost of Producing Silage

Silage corn as grown in the Corn Belt requires the same man and horse labor per acre up through the time of the last cultivation as ordinary corn, or, roughly, 11 man hours and 32 horse hours. At 34 cents an hour for man labor and 15 cents an hour for horse labor, this amounts

to \$8.54. The labor at silo filling time varies considerably with the distance of the field from the silo, but averages per acre about as follows:

	Man labor	Horse labor
Cutting with binder	1.7	5.1
Loading bundles	.4	.9
Hauling from field and unloading	7.0	14.0
Running engine and cutter	3.0	
Packing in silo	2.9	
Total hours per acre for corn cutting and silo filling	15.0	20.0

At 34 cents an hour for man labor and 15 cents an hour for horse labor, the labor charge for silo filling operations would be \$8.10 per acre. The total labor of growing an acre of silage corn, in the center of the Corn Belt, is about 26 hours of man labor and 52 hours of horse labor, or, with prices as mentioned, a total labor charge of \$16.64. The interest and depreciation on the silo is roughly \$4 an acre, and the machinery and equipment charge is \$6. About 3.5 pounds of twine are used per acre, or, roughly, 40 cents' worth. If the use of 40-bushel corn land (eight-ton silage land) is put in at \$10 per acre, we get a total of \$37.04 per acre under the same conditions as the production of corn husked from standing stalks costs \$25.14. The silage at eight tons to the acre, would cost about \$4.86 per ton under the same conditions as the corn would cost 62.8 cents a bushel in the crib in December.

CHAPTER 24

INSECTS OF CORN

INSECTS that attack corn are numerous, but most of them do not cause serious damage. Occasionally local attacks are severe and the entire crop of a community will be destroyed as a result of the work of a particular insect. Control measures, to be practical, should be simple, cheap and easily applied.

Most common corn insects have four stages in their life history, which may last a part of a year, one year or several years. The four stages are the egg, larva, pupa and adult stage. An adult insect usually deposits several hundred eggs and its function in life is completed. The eggs, as a rule, hatch out quickly into the larval or worm stage. After the worm finishes feeding, it turns into the pupal or resting stage. From the pupa emerges the adult as the butterfly does from the cocoon. Some insects such as the aphis bear live young.

The description of the insect, life history, the character of damage done and the control measures are given of the important insects of corn in the Corn Belt. The insects are divided into five classes, those that work primarily on the (1) roots, (2) stalks, (3) leaves, (4) entire plant, (5) stored grain.

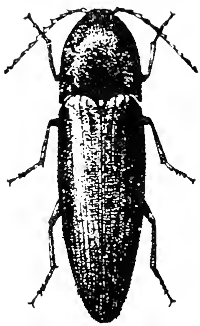
INSECTS THAT WORK ON THE ROOTS

Wire-worm

The common wire-worms are reddish-brown in color, hard and rather shiny in appearance, cylindrical in shape and an inch or more in length. The adults are boat-shaped fellows, one-half to three-fourths of an inch long and brown or black in color. They are known as "click beetles" or "snapping beetles," from the snapping noise they make when on their backs.

The wire-worm changes to the pupal stage in July or early August. Only two or three weeks are spent in this stage before changing to the beetle. The beetle, however, spends the winter in the pupal cell and comes out the next spring. It deposits its eggs in the soil. The larvae hatch out in a few days and begin feeding. The corn wire-worm may spend as long a time as five years in the soil, while the wheat wire-worm spends only three.

The failure of seed to sprout or the withering of corn plants at two feet or less in height, often indicates wire-worm attack. Wire-worms feed first on the seed itself, later on the roots. If the affected field has been in grass a year or so previous, the injury is most likely to be



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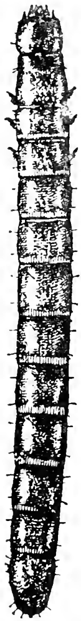

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(a) Wire worm beetle or click beetle. (b) Wire worm. (Much enlarged; the full grown wire worm is only about 1½ inches long.)

that of wire-worms. The larvae do not cause any visible injury to grass. However, when grass land is put into corn, the wire-worms concentrate upon the hills of the planted grain and cause much damage.

Wire-worms are difficult to control because, (1) they work underground; (2) they cling to life; (3) there are several injurious specimens of wire-worms requiring different methods of control.

There are many useless or impractical control measures often recommended. They are (1) coating the seed with various poisons or repellants, such as tar, kerosene, Paris green and strychnine—an Iowa county agent says the insects enjoy and eat the protected kernels more readily; (2) treating the soil with salt, and (3) plowing late in the fall. There seems to be no practical way of controlling wire-worms.

Corn Root Aphis

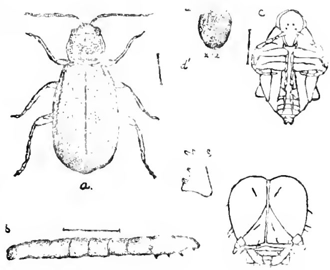
The corn root aphis or root louse is a tiny blue-green adult. The root lice which hatch from the eggs in the spring are all the same sex, females, which produce during the summer ten to twenty generations of live young. These females are found throughout the spring and summer and the males do not appear until the fall. The root lice multiply very rapidly and cause much damage to growing plants. Most of them are wingless, but occasionally winged forms are found. In the fall, both males and females appear. Mating takes place, and the females deposit eggs, instead of producing young. These eggs are taken up by the little brown ants, which care for them in their nests during the winter. The root lice are very well cared for by the ants, because the aphis secretes a sweet substance, "honey-dew," of which the ants are fond.

The presence of the corn root aphis in a field of growing corn is usually shown by (1) a dwarfing of the plants and a yellowing or reddening of the leaves; (2) finding numerous ant hills near affected stalks; (3) the presence of many lice on the main roots. The tiny lice suck the juices from the roots, thereby weakening the growth and reducing the yield.

Crop rotation is the most effective measure against the root aphis, although it feeds on other plants than corn. Where crop rotation with only one or two consecutive crops of corn is practiced, little injury occurs. The other crops grown are not much affected, as corn is the favorite food of the corn aphis. If it is not practical to rotate, deep and frequent cultivation early in the season may help.

Corn Root Worm

The root worms are small, slender, white grubs, about half an inch long when full grown. The northern form of the root worm in its adult stage is a plain grass-green beetle, about one-fifth of an inch long. The beetle of the southern root worm is green, with twelve black spots on its back. It is also somewhat larger than the plain green beetle, measuring nearly a quarter of an inch long.



(a) Corn root worm beetle is grass green in color and is found in late July and August, feeding on corn tassels and corn silk. (b) Corn root worm burrows into corn roots, causing corn to blow down easily in late summer. (Enlarged.)

In the fall, the beetle of the northern form may be seen on the silk of corn and the flowers of the goldenrod. The beetles deposit their eggs in the soil near the stalks of corn. The next spring these eggs hatch out early. The young root worms begin to attack the corn almost as soon as it is out of the ground. Throughout the summer, the larvae work on the roots. When the larvae mature, they change to the pupal stage, in which they spend only a short time. The plain green beetle emerges from this pupa and the life history is repeated. The black-spotted beetles of the southern corn root worm are found not only in the fall, but all through the season, from early spring onward. There seem to be at least two generations of them during the year. The life history of the southern corn root worm is similar to that of the northern form, except that it is passed through in a much shorter time.

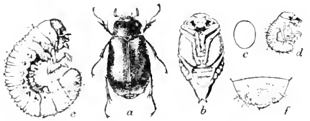
Corn is the only food plant of the northern root worm. On the other hand, the southern root worms have been found in wheat, rye, millet and other grasses. The northern form does more injury to the corn in the north. The withering of young plants and the blowing over of the stalks may be due to the root worm. However, more often these conditions are due to other factors.

If the plain green or the black-spotted beetles are seen in very large numbers feeding on the silks of the corn in the fall, it is an indication that a corn field on the same piece of ground will be infested with the root worms the next year. Those fields should be planted to some other

crop than corn, and the corn put on a new field. Rotation is an almost infallible cure for the northern corn root worm, but is not such a certain preventive of the southern form.

White Grub Worm

The grub is a large white insect with a reddish-brown head. It is similar to the grub found in manure piles, although the latter is not injurious to corn. The parent form of the white grub is the common May beetle or June bug, the large, black or brownish beetle which flies to the lights in May and early June.



(a) June bug. (e) Full-grown white grub ready to pupate. (d) Half-grown grub at stage when it does the most damage to corn. (Reduced.)

The beetles hide in the grass all day and after sun-down feed on the leaves of trees, often doing considerable damage. They deposit their eggs in rather compact soil, usually sod ground, during June. These eggs hatch and the young grubs begin to feed upon the roots of the grass that summer. Grubs do not become full grown for two years, and even then they remain in the soil for a third winter, emerging as beetles nearly three years after the eggs were deposited. A generalized life history is as follows:

First year—In May the beetles emerge from the soil, feed, and deposit eggs. Larvae hatch, begin to feed, and winter over in the soil.

Second year—Larvae feed during the season. The most damage to crops is caused this year. The larvae winter over in the soil practically full grown.

Third year—Larvae feed early in the season, pupate in June or July, and change to beetles a few weeks later. The beetles stay in the soil over winter.

Fourth year—Same as the first. Beetles emerge in May and early June.

The presence of the white grub is indicated by (1) dwarfing of the plant, (2) killing of the plant in any stage of growth, (3) weak root system, (4) falling of the stalk. The grubs are not known to infest such crops as clover, alfalfa or buckwheat; these may safely follow sod in a "grub year." Small grains are attacked by the grubs, but to a less extent than corn or potatoes.

Under certain conditions, grubs may be controlled by an intelligent rotation, particularly in a district known to be badly infested. Grubs are usually abundant near wooded areas. When grubs are expected in any particular year, corn should not follow sod. It may safely follow a cultivated crop. By referring to the generalized life cycle, one may

determine when to expect damage by grubs. For instance, if the beetles are exceptionally abundant one year, a large number of grubs may be expected the next year. In any given locality, the grubs are likely to be numerous at three-year intervals. For example, northeastern Iowa has had outbreaks in 1912, 1915, 1918 and 1921. If the two-year-old grubs are damaging corn, there is no practical measure to get rid of them at once without injuring the crop. However, such measures as fall plowing, rotation and turning hogs in on grub infested land may partially prevent further injury. Hogs turned into infested fields by the middle of October, before the grubs go deep, will rapidly clear out most of the grubs. The only objection to turning in hogs is that occasionally they become infested with the thorn-headed worm, which is a parasite of both hogs and white grubs. Because the grubs go deeper into the soil for the winter, early fall plowing is of some value, as it brings the grubs to the surface and crushes many of them.

INSECTS THAT WORK ON THE STALKS

Cut-worm

Full grown cut-worms are about one and one-half inches long, usually dull in color. Rarely, as with the variegated cut-worm which attacks clover, are they well marked or striped. Late in June or early in July the mature larva forms a loose cell in the soil, changes to the pupal stage, and a few days later to the adult or moth. Moths of the various species are much alike. All are dull in appearance and brown in color, with the hind wings lighter than the fore wings.

The moths deposit eggs in the grass lands late in the season. The larvae hatch the same fall and spend the winter in the soil partly grown. Consequently, they are of good size by the time the young corn plants are pushing their way through the ground. There is usually only one generation each year.

The cutting off of the stalk at the base of the plant, at or just below the surface of the soil, is the work of the cut-worms. Usually, the insect responsible for the damage may be found in the soil near the plant attacked.

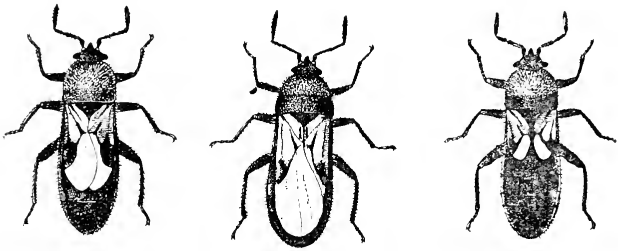
If cut-worms are present in a corn field, the only two measures to be taken are replanting and poisoning. Replanting should be delayed until damage by the insects has practically ceased. Although the cut-worm pupates in late June, it usually does very little severe damage after warm weather comes on in early June. A poison bait may be made by mixing one pound of Paris green with twenty-five pounds of dry bran or middlings. Scattered over a corn field, this bait attracts the cut-worms, which feed on it and are killed. Results are sometimes very good, but occasionally this method seems to be worthless.

Early fall plowing of grass land to be planted in corn the next year is a preventive measure. This plowing buries the eggs or young larvae

so they can not live over winter. Close fall pasturing of such land is also a benefit. Corn land should be disked and harrowed as much as possible before planting.

Chinch Bug

The adult form of the chinch bug is about one-fifth of an inch long, black in color, with the under wings whitish. These wings cross on the back of the insect, forming a sort of an X-shaped mark. Young chinch



Adult winged forms of chinch bug. The larval form, which invades corn fields, looks like this, but has no wings.

bugs are pale yellow at first, becoming quite reddish later. At first, there are no traces of wings, but in the later stages wing pads appear. Chinch bugs shed their skins four times and after the fourth moult become full grown.

During the winter, chinch bugs hibernate in clumps of grass and along fences and hedge rows. In April they go to the wheat fields, which offer plenty of food at this time. They soon deposit their eggs and their young feed on the wheat. At wheat harvest, the bugs of the preceding year are dead and the young ones have not developed wings. The bugs seek green food, and since they are unable to fly, they crawl from one field to another. Growing corn at this time is especially tempting to the partly grown chinch bugs, and the object of the control measures is to keep the bugs out of the corn. Chinch bugs mature in the corn field in July and deposit eggs for a second generation. They grow rapidly and feed on the corn. In September, the second generation matures and spends the winter as adults.

Since 1900 most chinch bug damage has been to corn south of the southern Iowa line. Back in 1887, however, chinch bug injury was noticeable in three-fourths of the counties of Iowa. Damage to corn occurs, for the most part, in midsummer, when the growing bugs pass from ripening wheat to corn. It does not necessarily follow that the chinch bug will not become dangerous in localities where no wheat is grown, although such usually is the case. Chinch bugs drive their beaks into the plant tissue and suck the juices.

In general, the four control methods for the chinch bug are (1) cleaning all rubbish and waste places, (2) barriers around fields, (3) spraying, and (4) natural enemies.

Since the chinch bugs hibernate in clumps of wild grass and similar places, much benefit may be obtained by burning rubbish along fences and hedge rows, in the winter. Clean culture does away with hibernating places in a field.

As wheat harvest in an infested field draws near, measures to prevent the insects from entering the corn field should be taken. This is best done by making barrier lines of some repellant, such as road oil or creosote, around the infested field. The road oil barrier must be kept so sticky that the chinch bugs can not cross it, but the creosote acts on account of its repellant odor. The strip of oil should be half an inch thick or more. Post holes about two feet deep should be dug at intervals of about twenty feet, along the oil line. A little kerosene poured into these holes will kill the bugs that collect. These barriers must be kept freshened.

Calcium cyanide was extensively used as a chinch bug barrier for the first time in 1923. It seems to be quite satisfactory, but rather expensive. After more experimentation has been done, further information should be obtained from the Missouri and Illinois stations.

Once the bugs are in a corn field, spraying with tobacco extract or kerosene emulsion is the only measure available. This is usually impractical.

The natural insect enemies of the chinch bug are not numerous, nor do they thrive in hot, dry weather. On the other hand, chinch bugs are the more numerous and thrive best under these conditions. However, the natural enemies have done much to reduce the number and extent of chinch bug attacks.

In southern Illinois they have found it well worth while to reduce chinch bug damage by growing varieties of corn with unusually large, sturdy stalks, wide leaves, and more than usually vigorous roots. The Democrat or Champion White Pearl is probably the best of these varieties. Under conditions of moderately severe chinch bug infestation, the Democrat will yield twice as much as Reid Yellow Dent, whereas, on the same soil, without chinch bugs, the Reid corn will usually yield two or three bushels more per acre.

Corn Bill-Bug

There are several kinds of bill-bugs. Most of them are black or brown in color. All are beetles with hard backs and long snouts, which make the holes in the leaf blades. In the grub stage, the corn bill-bugs feed on the roots of certain grasses. One of the most common species feeds on timothy roots.

In general, the insects spend the winter in the beetle stage and work in this stage upon the young corn plants in the late spring. In

the early summer, the beetles deposit their eggs on timothy and other grasses. The eggs hatch and the young grubs feed on the grass roots until early fall, when the adult beetles appear. Before changing to beetles, the grubs enter the pupal stage for a short period.

The tender leaves injured by rows of holes cut across the blade, is the work of the corn bill-bugs. The injury occurs when the plant is a few inches high, and the leaf blade is still within the sheath of the corn stalk. The holes do not become conspicuous until the blade has grown out. Since the blade is curled up within the leaf sheath, one hole made in the leaf sheath means six or eight holes in the curled leaf blade. Corn planted on timothy sod that has been infested with these grubs is likely to be damaged, especially if the sod has been turned under in the spring.

It has been found that the early fall or summer plowing of sod lands which are infested with these grubs, reduces greatly the injury if corn is put in the field the following year. The stirring of the soil disturbs the insects so that they are unable to survive the winter.

Army Worm

The army worm resembles the cut-worm. The color varies from yellow to brown or black. There are three stripes, a middle black one and an upper and lower yellowish one, on each side. The worm pupates in the soil. The pupa gives rise in ten to twenty days to a moth. The moth is a night-flying insect and is often attracted in large numbers to light. The fore wings of the moth are yellowish-brown in color and are marked with a small white speck near their center. Each female moth is capable of laying about 700 eggs.

These eggs hatch into small green worms in about eight to twelve days. The young worms eat but little and feed close to the ground. They may be in a field in great numbers and still escape detection. The worms are nearly full grown before injury becomes serious. Three to five weeks are required for full growth. The worms then are one and one-half inches long and one-eighth of an inch wide.

While the army worms prefer to breed and feed in grass or small grain growing in low and moist parts of fields, they become so abundant and food material so scarce, that the worms are forced to seek other places for their food. On such occasions, the worms migrate in vast armies and enter a corn field if it is in their path. The migrating worms climb the stalks and strip the plants of their leaves. The worms hide during the daytime under clods of dirt and rubbish, and feed during the night.

There are several control measures for the army worm. Infested areas may be mowed, covered with straw and burned. If migrating, the worms may be destroyed by spraying, by scattering poisoned bait, similar to that used for cut-worms, or by trenching, as described for the chinch bug.

Grasshoppers

There are several species of grasshoppers. Most every one is familiar with the ordinary adult which does the damage to crops. The habits of the usual species are much alike. The grasshopper has no larval stage.

The grasshoppers usually lay their eggs in the fall of the year and then die. The eggs are laid in masses in the ground. As many as 127 eggs have been found in a single egg mass laid by one of the large species of hoppers. Each female ordinarily produces two egg masses. The eggs remain in the ground over winter. The following spring, during May and June, the eggs are hatched. The young insects feed and grow and at intervals shed their hard skin. After the skin has been moulted for the fifth time, the insect is fully winged and the females are ready to lay eggs.

Ordinarily, grasshoppers do not breed in corn fields, but may invade such fields from neighboring ones where alfalfa, grain or grass is grown, or from unplowed edges of fields and roads. They eat the leaves, silks and husks of the corn plant.

There are several control methods. Poison bait made as follows is good:

Bran or mixed bran and sawdust	25 pounds
White arsenic or Paris green	1 pound
Salt	1 pound
Cheap molasses	2 quarts
Water	10 quarts
Amyl acetate (technical)	1 ounce

This amount of bait is sufficient to scatter over two acres. It should be scattered early in the morning.

Corn Ear-Worm

The ear-worm is the common greenish or brownish worm that eats into the ears of both dent and sweet corn. The adult is a brown moth.

As there are three generations in one year, and each female produces 200 to 300 eggs, this insect can increase rapidly. They go over the winter in the pupal stage. The moth emerges early in the spring and deposits eggs which hatch by the time corn is planted. The first two generations live on the leaves, but the third generation attacks the ears.

It is especially damaging to sweet corn. In the South it plays havoc with the dent varieties. The young worm begins to feed on the silks and kernels at the tip end of the ear. The full grown worm tunnels down the ear toward the butt end. The same worm feeds on the cotton boll, the tomato and tobacco bud.

There appears to be no reliable measure for controlling the corn ear-worm. Fall plowing has often been recommended, but it is doubtful if this measure is effective. The insects breed with such rapidity during the summer that any benefit of fall plowing is overcome. Some benefit has been obtained by dusting sweet corn during the silking

period, with powdered lead arsenate, but this is not practical except with sweet corn. Varieties that have long, tight-fitting husks are protected to a certain degree from the work of this worm. Late planted corn seems to be more susceptible to ear-worm damage than early planted corn.

The ear-worm should not be confused with the extremely injurious European corn borer, which is described on page 133.

American Stalk Borers

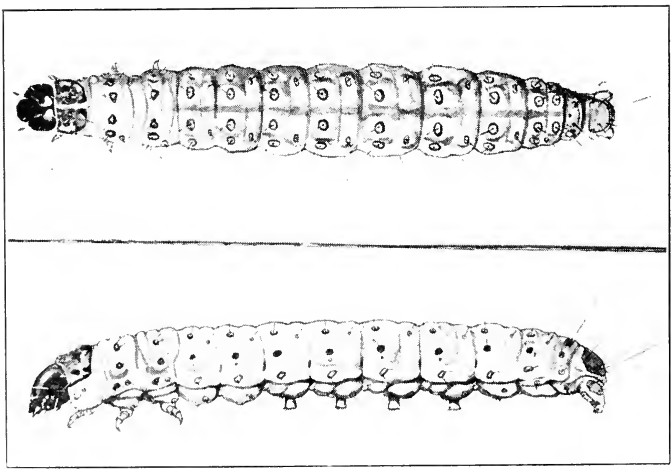
There are several kinds of stalk borers. The chief importance of these insects is the possibility of confusing them with the much-feared European corn borer, which is described on page 133.

One stalk borer commonly found in the Corn Belt has broader, darker brown stripes than the pale stripes of the European borer. It does its work early in the season, whereas the European borer is most active after tasseling time. The American stalk borer does little damage and its control is not important.

INSECTS THAT WORK ON THE ENTIRE PLANT

European Corn Borer

The adult is a moth which flies from place to place and deposits eggs upon the plants of its choice. These eggs hatch into smooth caterpillars which bore into the stalk. In the case of corn, the entire plant, including tassel, stalk and ear, is invaded.



European corn borer (greatly enlarged). The full-grown caterpillar is about one inch long.

The larvae pass the winter in the stalk. The borer is rather light in color, with a row of small, dark-brown spots on each segment, while several dark brown or pink lines extend lengthwise of the body. Because the adult is a moth, the borer is easily spread. The moths either fly or may be blown for great distances.

It is one of the worst corn pests of Hungary. It was introduced into the eastern United States in 1917, and has rapidly moved west. As yet, it has not reached the center of the Corn Belt, but the danger is great. Corn is the preferred food, but it will also attack many grain crops and weeds.

The one practical method of control when it reaches the Corn Belt will be community co-operation in the careful burning of all corn stalks before the middle of May. Late planting may also help.

The European corn borer has possibilities of causing as much damage to the corn crop as the boll weevil has caused to the cotton crop. There is grave danger that it will reach the heart of the Corn Belt by 1930.

INSECTS THAT WORK ON STORED CORN

There are several insects of stored corn, only a few of which are mentioned in this chapter. On account of the severe winters, they ordinarily do not damage corn greatly in a large part of the Corn Belt, especially the northern section.

The Angumois grain moth, the Mediterranean flour moth and the weevil are three insects of stored corn that are often found in large numbers where the storage temperature is above freezing during the winter. The weevil is injurious to the stored grain of many crops. The small brown adult beetle punctures the kernel and inserts its egg. The white larva or grub lives inside and eats the kernel. Several may be found in one kernel. The pupal stage is white and transparent. The Mediterranean flour moth is injurious to many grains, especially wheat. The adult is a small gray moth. The silken webs spun by the larvae are troublesome. The Angumois grain moth is not numerous in the Corn Belt. The small round holes in a kernel of corn are indications of attack by this insect. The moths are light brown in color. The larva is a small, whitish worm.

Under farm conditions, the only practical control is fumigation with carbon disulphide, a heavy liquid, which is volatile. The gas formed is heavier than air, and so the liquid must be placed at the top of the room or building to be fumigated. One pound is sufficient for 50 to 100 bushels of grain, depending on the temperature and the type and size of building fumigated. The gas is highly inflammable, and so all lights and fires should be kept away from the building being fumigated. It is also slightly poisonous. Hydrocyanic gas is effective but extremely poisonous. Heat may be used in mills or elevators as a remedy.

Other Pests

Birds, like the blackbird and crow, eat a large amount of the planted seed, and in some cases some of the crop. Rodents and rabbits often cause a reduced stand by eating the seed. Some farmers attempt to poison these pests. Others spread a bushel or so of well-soaked corn in a field adjacent to a newly-planted field of corn. The pests feed on this soaked corn and do not disturb the planted seed.

CHAPTER 25

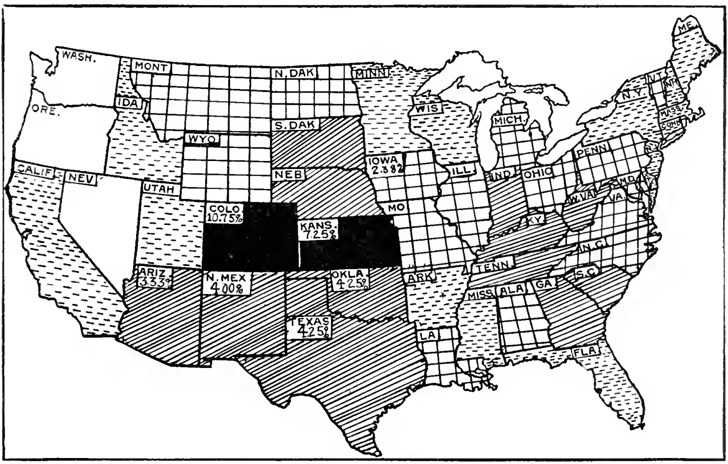
DISEASES OF CORN

CORN is freer from disease damage than most other crops. The two important groups of diseases of corn are corn smut, with which every corn grower is familiar, and root rot, fusarium, diplodia and similar diseases to which so much attention has been directed in Indiana and Illinois. Previous to 1913, much of the damage caused by this latter group of diseases was attributed to the corn root-worm, the corn root-louse, or to drouth. These diseases are not well understood. There are possibly ten different bacterial or fungus organisms which play some part in root rotting, stalk stunting, leaf rolling, joint discoloration or leaf reddening in the corn field.

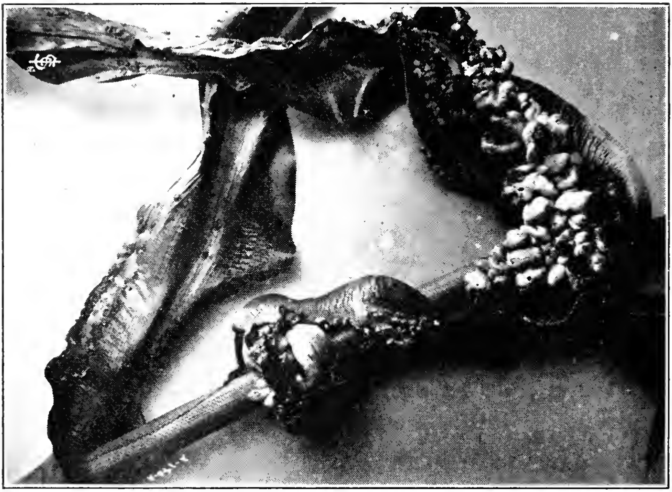
Corn Smut

All corn growers are familiar with the black balls of corn smut which are found in every corn field. It is a typical fungus with the mycelium growing inside the stalk or leaf of the corn plant. Externally, smut first appears as a rather lustrous, lead-colored bump, but

MAP NO. IX



Estimated percentage of corn crop destroyed by smut. Solid, over 5 per cent. Diagonal lines, 2.6 to 5 per cent. Squares, 1.1 to 2.5 per cent. All others under 1.1 per cent.



Corn smut. (Courtesy of Iowa Station.)

this bump swells and darkens until it bursts and lets loose the black smut spores, which are in effect the seeds which carry over the disease in the soil for another year. In the average field, smut causes the loss of one-half to one bushel an acre, but in many fields it causes the loss of two or three bushels an acre. Map IX, based on information compiled by the United States Department of Agriculture, indicates that smut is a much more serious matter on the extreme southwestern edge of the Corn Belt than it is in the central part. Possibly extreme drouth and heat are favorable to the development of corn smut.

No one has discovered any effective way of preventing corn smut. Rotation helps some. After corn has been grown on the same field for more than two years, the infection seems to get worse. Theoretically, it should help to go over the field several times in July and August and pick off the smut balls before they burst, but this is absolutely impractical. Treating the seed with formaldehyde, in the same way as small grain is treated for smut, does not reduce the percentage of smut. The one practical method of attack is to breed for strains of corn which are smut-resistant. It has been definitely proved that some strains of corn are much more smut-resistant than others. It would seem to be worth while to avoid picking seed ears from stalks which show the slightest signs of smut infection. The constructive corn breeders of the future will do some of their best work in developing high yielding strains of corn which are much more resistant to smut than any which we now have.

Corn smut is not poisonous. It has been fed in large quantities to live stock without bad effects. In fact, an eastern experiment station states that it makes an excellent substitute for mushrooms, for human consumption, if gathered before reaching the bursting stage.

Diplodia

Probably the most clear-cut and outstanding of the root-rot group of diseases of corn is diplodia, which infects the entire plant but manifests itself most noticeably in the form of moldy ears—ears which are moldy altogether apart from any mold following damage by the corn ear-worm. White streaks of mold found between the kernel tips are almost certain signs of diplodia. In bad cases, the entire ear will be a mass of white mold. Many apparently good seed ears are slightly infected with diplodia, and when planted produce a very high percentage of stunted and barren stalks. One of the most important things to look out for when shelling the seed ears by hand is to throw out any which show the slightest trace of mold at the kernel tips. Diplodia is doubtless carried over from one year to the next in the soil as well as in the seed corn, but there is apparently nothing that we can do about the presence of the disease in the soil. Diplodia does not do so very much damage if strong, mold-free seed is planted, provided the late summer and early fall is not unusually moist and warm. In 1922 and 1923 experiments of the United States Department of Agriculture in central Illinois indicated that it is possible to treat seed corn so as to free the seed from diplodia infection. No information is available as yet as to the substance used.

Fusarium

There are many species of fusarium attacking a great variety of plants. Ordinarily, they are not so very serious. One of them, when weather conditions are just right, causes scab in wheat. It has been definitely demonstrated that the same fusarium (Gibberella S. is a type of fusarium) may, when corn is following wheat, cause very serious damage to corn. There are several other fusariums infecting corn, and most of them are carried over winter not only on the corn stalks but also inside the kernels of corn. No method of treating the corn with formaldehyde will free the kernels from infection. Apparently all that can be done is to pick out the ears that are infected and avoid planting them. Illinois experiments indicate that seed which is infected with fusarium will yield fully 20 per cent less than disease-free seed. Iowa experiments indicate that under favorable conditions of soil and weather there is very little difference in yielding power between seed infected with fusarium and seed not infected. There is no question about the low yielding power of seed infected with diplodia, but there do seem to be some conditions under which fusarium is not so very serious.

Controlling the Root-Rot Diseases

From the standpoint of practical action against the root-rots, the first thing is to select normally matured ears from normal stalks in the field. Go over the seed ears and throw out all having kernels with starchy backs. Throw out the ears that are light for their size and which show any sign of disease at the shank. Shredded, dull-colored shank attachments indicate disease. The next step is conducting the germination test with unusual care and with an eye open for signs of infection. However, the Ohio station states that although experts can use the germination test to select disease free ears, the average person can not make practical use of the germination test from the disease standpoint. There are two methods of testing for diseased ears. One is a table germinator with a limestone-sawdust base. The other is a modified rag doll.

Modified Rag Doll

The following directions are designed to help in constructing the special form of rag doll to pick out infected ears:

1. Lay a 12x60-inch strip of firm, water-finish, fiber (butcher's paper) on a table.
2. On top of the paper lay a 12x54-inch moistened strip of muslin.
3. Place eight representative kernels from each ear in a row, with germ sides down and tips pointing in the same direction.
4. Roll the paper and cloth into a doll, as described in the making of the rag doll.
5. Store the dolls in a warm, moist place for seven days.
6. The stored dolls should not come in contact with one another.
7. A box with wire cross rods three inches apart in the upper part of the box is suitable for storage.
8. Keep the dolls moist and see that the container allows drainage.
9. Unroll the dolls and read the test.
10. The percentage of germination of each ear is determined in the usual way, and the seedlings are then examined for molding or rotting. The seedlings which have discolored or rotten stems or roots, or which come from rotten kernels indicate ears infected with disease.

Disease Resistant Corn

It will not be until 1930 or later that we have any very complete knowledge concerning this group of diseases. It is probable that eventually it will be found that the best way of meeting these diseases will be by the breeding of disease resistant strains. Preliminary work indicates that some strains are much more resistant than others. Here again is a great field of work open for the constructive corn breeder.

Effect of Soil

Hoffer, working in Indiana, and Holbert, working in Illinois, have both found that soil conditions have much to do with these diseases. Where the soil is acid and corn is grown year after year, it seems that

these diseases are likely to grow in virulence. Presumably this explains why these diseases are regarded as so much more serious in the eastern part of the Corn Belt than in Iowa.

Conclusion

In the present state of our knowledge, the practical way of handling these diseases is to apply lime to acid soils, grow clover once in four years, avoid growing corn on the same land more than two years in succession, burn the corn stalks, avoid following scabby wheat with corn, and plant seed corn which the germinator indicates to be disease-free.

Other Diseases

Corn rust is a common disease of the plant. This disease affects mainly the leaves and tassel of the plant, and interferes with their functioning. However, the damage is not great, and so little attention has been given to control measures. Other diseases of corn are sheath spot, wilt and damping-off.

CHAPTER 26

CLASSIFICATION OF CORN

CORN is a summer annual which belongs to the grass family. Such other common farm crops as wheat, oats, barley, rye and sorghum also belong to the same family. Incorrectly, flax and buckwheat are often called grasses. Botanists classify the corn plant as follows:

Botanical Division	Name	Characteristics
Family	Gramineae	Fibrous root system leaves alternate, parallel veins in leaves, split leaf sheath, ligule, stems cylindrical with solid nodes.
Tribe	Tripsaceae (maydeae)	Male and female flowers in separate places on the same plant.
Genus	Zea	Grain borne on a lateral cob.

Relatives of corn. To left, Job's tears, showing female flower below and male flowers above. To right, gama grass, with female tassels in lower part of tassel and male flowers in upper part. (a) female flower (enlarged); (b) male flower (enlarged).

Teosinte-corn hybrid plant produced by a single kernel. Note large numbers of suckers and branches which bear tassels. A plant of this sort will often produce forty ears, but each ear carries only ten or fifteen kernels.

Besides zea (corn), there are three other common genera belonging to the tribe Tripsaceae—Euchlaena (teosinte), Tripsacum (gama grass), and Coix (Job's tears). Teosinte and gama grass are described in Chapter 1. Teosinte will cross with corn, but as yet there have been no successful crosses of either corn or teosinte with gama grass or Job's tears. Job's tears is an ornamental garden plant. Large growing, soft shelled forms of Job's tears are cultivated as a grain crop in the Philippines and other tropical eastern countries.

There are several other genera belonging to Tribe Tripsaceae, which are found in India, but which seem as yet to be of no practical importance. From a strictly botanical point of view, there are no clear-cut species of the Genus Zea. Before the discovery of Mendel's law and its application to the genetics of corn, many distinct species of zea were recognized. Today most of these so-called species are looked on merely as interesting freaks which behave as Mendelian dominants or Mendelian recessives.

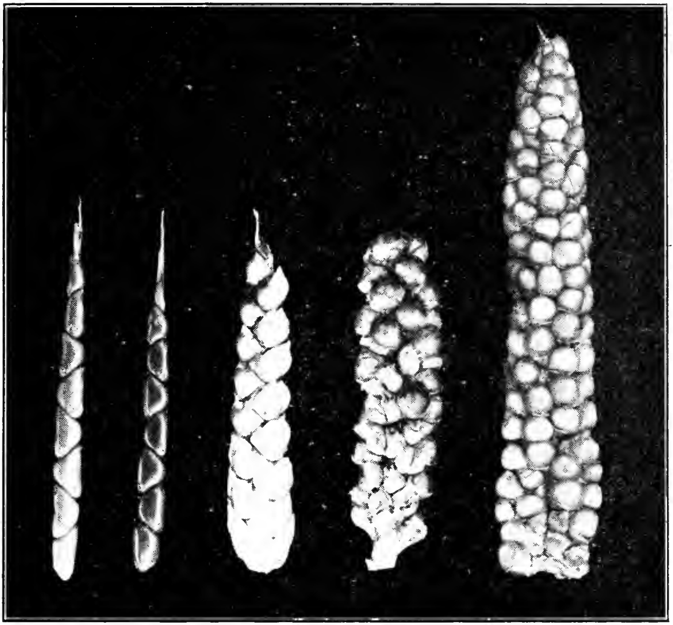
On the basis of kernel texture there are four common groups of zea (corn):

1. Dent.
2. Flint.
3. Sweet.
4. Soft.

Dent Corn

Dent corn is characterized by a depression in the crown of the kernel. This denting is caused by the unequal shrinkage of the hard starch found on the sides of the kernel and the soft starch which composes the crown. The character of the indentation varies all the way from a shallow dimple through a crumpled crease to a thin beak or hook. This last kind of indentation is characteristic of those dents with the highest percentage of soft starch toward the crown. Dent corn varies in color and in size and shape of ear. There is also a great variation in size and shape of kernel. Some ears of dent corn bear kernels of the extreme shoe-peg type, very narrow and deep. Other ears of dent corn bear kernels of the square type, very wide and shallow. In between are all gradations of kernel type.

The great diversity of type sketched in the foregoing, together with historical and genetic evidence, indicates that dent corn is not in any sense a species, but a conglomerate mixture. This mixture seems to have resulted from both accidental and intentional crossing of the large flint type (recognized as a distinct sort in the early part of the nineteenth century) with the gourd-seed, which seems to have been a late-maturing, rank-stalked type, bearing an ear with 22 to 36 rows of rough, deep, very soft, shoe-peg kernels. The ears were rather short, small-cobbed and very thick because of the great depth of grain. Some



Teosinte ear spikes on left. Three ears on right are types which result when teosinte is crossed with corn and the corn types are selected out. (Courtesy of United States Department of Agriculture.)

people have looked on the gourd-seed as being synonymous with dent corn. That this is not true is indicated by the testimony of farmers who grew both dents and gourd-seeds. For instance, one farmer who grew both wrote:

"Gourd-seed is a large, rough, soft corn. It is later and has larger stalks and ears than the other varieties. It lacks the flintiness and weight for the same bulk as the others have. In comparison with dent of my own raising, in feeding hogs, I thought it took about one and one-fourth bushels to go as far as one of my own corn. But cattle in particular will eat it more readily, as it is not so hard to masticate."

Mr. John Lorain, in his "Practice of Husbandry," published in 1825, refers to the common practice of mixing gourd-seed with other varieties:

"So prevalent are mixtures, that I have never examined a field of corn (where great care had not been taken to select the seed), which did not exhibit evident traces of all the corn in general use for field

planting, with many others that are not used for this purpose. None can be longer nor more readily traced than the gourd-seed.

"The quantity of the gourd-seed mixed with the flinty yellow corns, may be determined, so as to answer the farmer's purpose. When the proportion of the former greatly predominates, the grains are pale, very long and narrow, and the outside ends of them are so flat (beaked) that but little of the indenture is seen. As the portion of the gourd-seed decreases in the mixture, the grains shorten, become wider, and their outside ends grow thicker. The indentures also become larger and rounder, until the harder corns get the ascendancy. After this, the outside ends of the grain become thicker and more circular. They also grow wider, and the fluted appearance between the rows increases. The indentures also decrease in size until they disappear, and the yellow, flinty variety is formed. But, as I believe, not so fully but that the latent remains will forever subject it to more or less change. It is more difficult to determine the quantity of big and little yellow flints, which may happen to be mixed with the gourd-seed, and at the same time with each other. The soft, open texture of the gourd-seed renders it unfit for exportation, unless it be kiln-dried."

Lorain, previous to 1825, stated that true gourd-seed is white:

"It is invariably white, unless it has been mixed with the yellow flinty corns. Then it is called the yellow gourd-seed, and too many farmers consider it and most other mixtures original corns. I have often heard of original yellow gourd-seed corn, but after taking much trouble to investigate the fact, could never find anything more than a mixture. If there be an original yellow gourd-seed corn, it has eluded my very attentive inquiry from the Atlantic to our most remote western settlements."

Lorain also says that much of the corn which passes for white gourd-seed has been mixed with white flint.

Peter A. Brown, LL. D., writing a paper on corn for the Chester county, Pennsylvania. Cabinet of Natural Science, in 1837, refers to true gourdseed as carrying twenty-four or more rows of kernels. He looked on ears carrying fourteen to twenty-two rows of kernels as mixtures of flint and gourdseed. No reference is made to dent corn, although he lists thirty-five different types, seven of which he states were originated by mixing gourdseed and flint. He mentions the King Philip as mixing especially well with gourdseed.

According to the twelfth Smithsonian Institute report, the Mound-builders of Arkansas grew a type of corn which is "judged to be the variety known in the South as the gourd-seed corn."

Beverly, in his history of Virginia, written in 1705, states that the Indians grew a late flint and a late dent. "The other has a larger grain and looks shriveled, with a dent on the back of the grain as if it had never come to perfection; and this they call She corn. This is esteemed

by the planters, as the best for increase, and is universally chosen by them for planting; yet I can't see but this also produces the flint corn, accidentally among the other." Evidently there was some crossing of flint and gourdseed to produce dent corn long before the time of John Lorain.

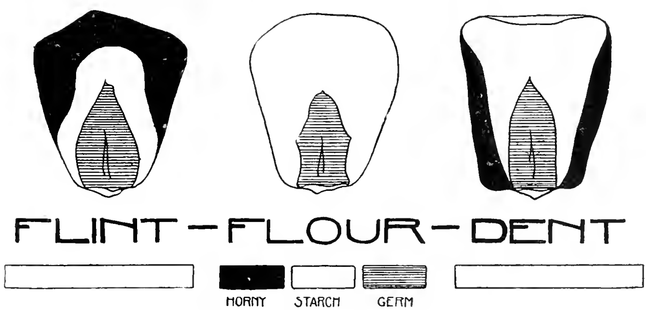
The genetic evidence in favor of the hypothesis that the typical dent varieties grown in the Corn Belt are a cross of the flint and gourd-seed corns, consists in the ease with which inbreeding isolates out types which are practically pure flints. H. A. Wallace has isolated out of the Clyde Black strain of Reid Yellow Dent a flinty type similar in appearance to the Dutton flint, popular in New York seventy years ago. Gourd-seed types, because of their lateness and susceptibility to disease, have thus far been difficult to isolate in their pure inbred form.

Of course, it is recognized that there may have been many other sorts mixed in forming the modern dent corn, but it is believed that the chief characteristics of dent corn as it is known in the Corn Belt today are due to the large flint and the gourd-seed.

Modern dents seem to contain varying percentages of flint and gourd-seed blood. Johnson County White appears to contain a high percentage of gourd-seed, whereas Northwestern Dent is unquestionably more than one-half flint.

The hybrid heredity of dent corn and the consequent variability and possibility of securing unproductive as well as productive mixtures, indicates that intelligent selection is probably more necessary with dent corn than with purer types.

Dent corn typically contains about 10 per cent protein, 68 per cent nitrogen free extract, and 4.8 per cent fat. It is one to two per cent poorer in protein and one to two per cent richer in nitrogen free extract than flint corn of the same moisture content. Shelled dent corn typically weighs 55 or 56 pounds per bushel, whereas shelled corn of the small seeded flints may weigh 60 pounds per bushel, and the flour corns may weigh only 50 pounds.



Illustrating difference of kernel texture in different types.

Flint Corn

Flint corn differs from dent corn in that it contains practically no soft starch; therefore, no indentation is formed. Most flints sucker profusely, and usually bear more than one ear per plant. Flint corns are good yielders and furnish excellent fodder. The corn meal made from flint corn is of superior quality. Most yellow flints are a much deeper yellow than yellow dents.

The four common classes of flint varieties are (1) early flints, (2) medium flints, (3) tropical flints, and (4) popcorn.

The early flints are the earliest varieties of corn grown in the United States. They grow only three or four feet high, and bear the ear within a few inches of the ground. The color is variable, and the ear six to seven inches long and usually carrying eight rows. This type is adapted to short seasons, high altitudes and dry conditions. Representative varieties are Gehu, Dakota White and Early Indian. Most of these early flints were developed by the Indians of the northwest with but very little improvement by the white man during the past thirty years.

The medium flint class consists principally of varieties that originated in New England and the Middle-Atlantic states. They grow from five to seven feet in height, but are finer stalked than the dent varieties. They vary greatly in size and color of ear and in length of maturity. Most of them are eight-rowed. Because of their fine stalks and numerous leaves, they make an excellent quality of fodder and silage. Representative varieties are Longfellow, King Philip, Smut Nose and Mercer. Both the early and medium flints sucker considerably and carry many streamers on their husks.

The tropical flints are not well known in the United States. Presumably, Columbus found tropical flints growing on the West India islands and introduced them to Europe. Many of the common flints of Italy, the Balkan States and Argentina seem to be tropical flints. The tropical flints, as modified by selection in these countries, require about 120 days to mature. Many of them do not sucker. The kernels usually are narrower and deeper than with the medium class of flints. Oftentimes the ears carry twelve rows.

Popcorn differs from the other flints in that it contains an even higher percentage of hard starch, the kernels are usually much smaller, and the hull in proportion to the size of kernel is tougher and thicker. Because of these characteristics, the kernel, when heated, has the ability to pop better than the other flints. Popcorn is discussed in Chapter 27.

While there is great variability among all four classes of flints, just described, there is reason to think that they are more uniform in their characteristics than the dents.

Sweet Corn

Sweet corns may be of the dent type (Evergreen) or the flint type (Golden Bantam), and also of soft corn types. Sweet corn, therefore, has the possibility of being one of the most variable of all corn types.

The only distinguishing characteristics of sweet corn are wrinkled kernels and translucent, hard starch, which does not mature normally, apparently remaining in the sugar stage much longer than is the case with ordinary corn.

Soft Corn

Soft varieties of corn are grown only to a very limited extent. They are also known as "squaw" corn and "flour" corn. Soft corn is usually similar to flint corn in plant and ear characters, but differs in that the kernels are composed largely of soft starch instead of hard starch. Like flint corn, it has no dent (sometimes there is a slight dent in Hopi Indian corn). The horny starch in soft corn is such a very thin shell at the sides of the kernel that it is impossible for any strain of this corn to be deep yellow in color (the yellow color of corn is found only in the horny starch).

Strains of soft corn are Brazilian Flour, Hopi and the Blue Flour of the Nebraska and Dakota Indians. Evidence indicating the purity of flour corn as an ancient type is the inbreeding work done by Kempton and Collins with the Pawnee Blue Flour. The Pawnee Blue Flour withstands inbreeding with less loss of vigor than any other strain of corn which has thus far been put through this severe test.

Other Types

Kernel texture, while convenient for practical purposes, is only one basis of classifying corn. Geneticists have studied hundreds of distinct types which the botanists of a generation ago would have dignified with Latin names as distinct species. Some of these types are:

1. Pod corn—each kernel enclosed by a husk as well as the entire ear.
2. Brachytic corn—short jointed corn which is normal in every respect except that the joints are only half the normal length. There are the usual number of leaves.
3. Purple-leaved corn—the leaves and husks are a deep, beautiful purple.
4. Japonica, or striped-leaved corn.
5. Hairy corn—hairs on the stems and leaves.
6. Ramosa corn—ear a round cluster of kernels without a true cob. (Discovered at the Illinois station.)
7. Corn bearing ears with lateral branches at the base of the cob.
8. Tassel ear corn—ears borne on tassels.
9. Waxy corn—logically, this should be included as a fifth member of the classification on kernel texture. The carbohydrates of the kernel are stored in the form of dextrin, instead of as starch. It is not shriveled, however like sweet corn.
10. Starchy sweet corn—like waxy corn, this logically should be included with the classification on basis of kernel texture. The upper part of the kernels is transparent and horny like sweet corn, and the lower part is starchy. This corn is grown by certain Mexican and Peruvian Indians. It can be produced by crossing true sweet corns with dent corn and then selecting out in later generations the sweet corn recessives which carry white starch at the base of the kernel. It is not grown commercially.

There are many more rather freakish types of this sort which have as legitimate claim, from a botanical point of view, to be known as species of zea as do dent corn, flint corn, sweet corn and soft corn. From a practical point of view, however, this classification into four groups, on the basis of kernel texture, seems best.

CHAPTER 27

POPCORN

THE growing of popcorn on a field scale in the Corn Belt is a specialized and localized industry. Profit in popcorn growing depends largely on the grower's ability to produce popcorn of good quality, store his crop properly, and market it advantageously. In comparison to field corn, popcorn is more bother to raise, harder to get a stand, more difficult to keep clean, and more bother to gather and deliver. In addition, marketing difficulties and fluctuating prices make it an unprofitable crop for promiscuous planting.

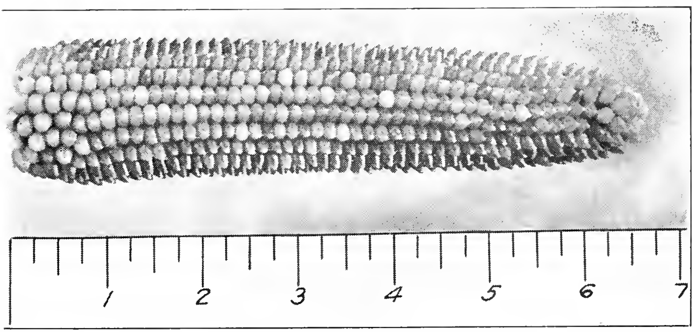
Why It Pops

Popping is the complete eversion of the kernel as a result of the explosion of the contained moisture when heat is applied. A 12 per cent moisture content is considered best for popping. This means that popcorn usually pops best after about six months of storage. Ordinary rice popcorn increases in volume from twelve to twenty times on popping. Certain high popping strains and the Jap Rice may increase in volume by as much as thirty times.

Types of Popcorn

The three common types of popcorn are White Rice, Jap and Pearl. In the great popcorn district in Sac and Ida counties, Iowa, the White Rice and Jap are grown almost exclusively.

White Rice—The kernels are pointed at the crown. Ears are seven or eight inches long and carry twelve or fourteen rows of kernels. The



Typical ear of White Rice popcorn, which is grown more commercially than all other kinds put together.

stalks are usually six or seven feet tall. It yields about 70 per cent as many pounds of ear corn per acre as ordinary dent corn grown on the same land. It is the outstanding popcorn of America, but the Jap is gradually replacing it to a considerable extent.

Jap—The kernels are pointed like the White Rice, but are much narrower. The ears are only two or three inches long. They carry typically from twenty-four to thirty-six rows of grain. Kernels are deep but exceedingly narrow. The stalks are about five feet tall. It will yield about 70 per cent as many pounds per acre as the White Rice and about half as many pounds as ordinary dent corn on the same land. Because of the small ears, it is difficult to husk. When huskers of dent corn are paid four or five cents a bushel (eighty pounds of ear corn), it is customary to pay huskers of White Rice about 15 cents per hundred pounds of ear corn and huskers of Jap about 23 cents per hundred pounds of snapped corn.

Jap corn suckers less than most strains of White Rice, and the main tassel spike is shorter and thicker. Many of the stalks are somewhat hairy. Two or three ears per stalk are common.

Jap produces a more tender product on popping than the White Rice, and is much in demand on that account. Some call it Jap Hull-less because it is so tender. It also increases more in bulk on popping than is the case with ordinary White Rice.

The market has normally paid from 40 to 100 per cent more for Jap popcorn per hundred pounds of snapped corn than for White Rice per hundred pounds of ear corn.

Pearl Popcorn—The kernels are rounded and shallow, and look like small flint kernels. The ears are about eight inches long and carry eight to fourteen rows. The eating quality of Pearl popcorn is low as compared with the Jap. The large popped kernels of the eight-rowed variety are strung on strings and used as ornaments at Christmas-time. The three common Pearl varieties are White Pearl, Golden Queen and Eight-rowed.

Cultural Methods

Popcorn is grown in almost exactly the same way as ordinary dent corn. It should not be planted after June 1, because popcorn which is the least bit immature is worthless. An ordinary corn planter with special plates is used to plant popcorn. It may be either checked or drilled. However, drilling is to be discouraged unless the land is exceptionally free from weeds. Five to six kernels are dropped in a hill, and often three feet four inch wire is used, so that the cross rows are forty inches apart and the planter rows forty-two inches. Five to six pounds per acre gives a good stand.

Cultivation is practically the same as that of the dent corn. However, the smaller plant makes the first cultivation a little more difficult. Three to four cultivations are the rule, and it is "laid by" at the same time or a little later than dent corn.

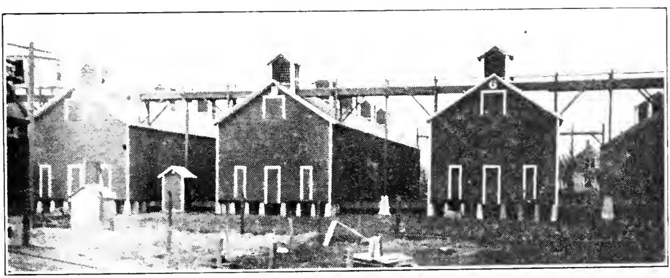
Popcorn ripens somewhat earlier than field corn, husking often beginning the last of September or the first of October. It should be fully mature before frost comes, as freezing injures the popping quality and greatly reduces its value on the market. The best quality of popcorn is obtained by allowing the ears to ripen fully on the standing stalks. Husking from the shock, while practiced in a limited way, is very poor practice. Formerly, popcorn was harvested exclusively by hand, but in late years the husking machine has come into favor as a means of getting the corn into the crib. Both methods have their good points. Three men operating a machine will crib as much corn as five men by hand. The husking machine is discussed in Chapter 13. Forty inches of White Rice per day is a good day's picking for a man. It seems to take at least twice as much labor to husk White Rice popcorn as it does dent corn.

Marketing

From 60 to 75 per cent of the entire crop is marketed before the first of January. Some is hauled directly from the field to the market. The crop is often contracted for before the seed is put in the ground. The contract price fluctuates greatly, but is usually around $2 per hundred pounds of White Rice ear corn when prospects are for dent corn selling for 50 cents per bushel of ear corn (eighty pounds) in December. Most of the popcorn cribbed on the farm is marketed shelled. Shrinkage, according to one authority, is about 30 per cent. Rat-proof cribs are often used, though rodents do less damage to popcorn than to dent corn.

Cribbing and Shelling

The Dickinson, Cracker-jack and Shotwell people, who buy the bulk of the commercial popcorn, have built large plants for the storage of popcorn. One plant in Sac county, Iowa, consists of four cribs with a capacity of 1,250,000 pounds each of ear corn, or a combined capacity of five million pounds; an elevator with a 350,000-pound shelled corn capacity, and five tanks with a capacity of two million pounds of shelled corn.



Popcorn cribs along railroad tracks, owned by one of the big commercial concerns in Sac county, Iowa.

Early in the summer, shelling starts in the big cribs and is kept up intermittently all summer, so that the cribs will be empty in time for the new crop. The sheller is built in as part of the plant, and endless belts convey the corn from the cribs to the sheller.

Amount Grown

Popcorn is grown in practically every state. However, the main portion of the market supply comes from Sac and Ida counties, in Iowa, and Valley and Greeley counties, in Nebraska.

Iowa is the leading popcorn state. Two counties, Ida and Sac, normally grow over 10,000 acres annually. The following table gives popcorn acreage in Ida and Sac counties for different years:

	1912	1919	1922
Ida county	5,412	11,411	2,996
Sac county	8,408	14,722	5,160

As to whether the decline in acreage indicated by the 1922 figures will prove to be permanent is rather doubtful.

Uses of Popcorn

Most of the popcorn is used as a confection. "Cracker-jack," "Checkers" and similar well-known delicacies are coated popcorn. In handling the commercial grades of popcorn, the wholesaler must figure on a waste of 7 to 25 per cent. This waste is made up of kernels that will not pop, kernels that are mixed with dent corn and dust or broken pieces of cob that the sheller did not clean cut. Considerable popcorn flour is used commercially. It is said that it is a fine light flour of unusually high quality.

CHAPTER 28

SWEET CORN

SWEET corn is extensively grown for canning purposes in many sections of the Corn Belt, especially in Iowa and Illinois. It takes about 1,000 acres of sweet corn to maintain an efficient canning factory. Sweet corn is an early cash crop, that is usually contracted for at planting time; hence, the marketing of the crop is not a problem. Sweet corn fits in well before winter wheat in the rotation, making for some sections a better combination than field corn and oats. The stalks left in the field after snapping the sweet corn are a valuable feed, worth $3 or $4 an acre. In general, sweet corn is a profitable crop for many farmers located within four miles of a canning factory.

How It Differs from Field Corn

The ordinary dent, flint and soft corns are usually referred to as field corn, although some of these types are occasionally used as roasting ears. Kernels of sweet corn are horny, wrinkled and translucent. The high sugar content of the kernel gives this type of corn its name and particular uses. Most sweet varieties are prolific and sucker greatly. As a rule, sweet corn requires a shorter season than field corn.

Uses of Sweet Corn

Most of the sweet corn grown on a field scale in the Corn Belt is sold to canning factories that are within hauling distance of the farms. Dried sweet corn is still used by farmers, and sweet corn on the ears in the "roasting stage" or "in the milk," is an important vegetable. A small amount is picked for table use. Although sweet corn yields less than field corn, a few farmers prefer it for hogging-down or sheeping-down. According to the Iowa station, "Sweet corn provides an early soiling crop. It may be harvested in early September before the field corn is sufficiently matured and at a time when green feed is usually scarce. Sweet corn silage has a very high value. The stalks are sweet, palatable, and contain less crude fiber and hence a higher percentage of digestible matter than field corn."

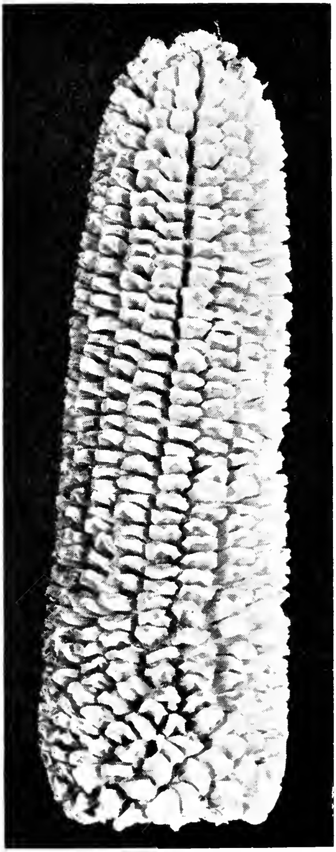
Varieties

Distinct varieties of sweet corn were not well developed until the last of the nineteenth century. Now there are a great number of varieties, which are usually classed as to time and maturity. The following ones are most commonly grown in the Corn Belt for canning purposes:

1. Stowell's Evergreen—medium late, most prominent canning variety.
2. Country Gentleman—late, good quality; yields less, but brings higher price than Stowell's Evergreen; canners like it because the grains are narrow.
3. Golden Bantam—very early, small, yellow, tender; prospects of becoming a very important canning variety in northern sections.

Soil and Climate

Good corn land is as important for sweet corn as for field corn. For a description of corn soils and fertilizers, see Chapter 8. Sweet corn is not as hardy as the field corns, and is more easily injured by frosts or backward spring weather. In addition, hot weather makes the corn tough. Cool seasons make a tender corn. Otherwise, the general relation of climate to sweet corn is about the same as for field corn.



Evergreen Sweet Corn.
A mature seed ear of good type.

Easy on the Land

Sweet corn when harvested at the canning stage does not exhaust the soil fertility as do most farm crops. It is a well-recognized fact that the processes involved in the maturing and filling out of the seed make a heavy drain upon the fertility of the soil. Sweet corn is harvested before this stage is reached. At this stage, ears are 75 per cent water. As sold to the canning factory, the ears from an acre of sweet corn remove slightly more potash, 55 per cent as much nitrogen and 25 per cent as much phosphorus as the ears from an acre of field corn. Since potash is not as important as nitrogen and phosphorus under Corn Belt conditions, it may be seen that sweet corn is quite easy on the land.

Sweet Corn Seed

According to Erwin, it is customary for the canners in the Corn Belt to "renew the seed supply, commonly from the New England States, every year or at frequent intervals. This practice seems to be based upon three assumptions: First, that sweet corn when grown continu-

ously under Corn Belt conditions loses in sugar; second, becomes starchy, and third, tough.'' However, Erwin's tests show that these assumptions are not always true, and that adapted home-grown seed should be used.

Cultural Methods

A well-prepared seed bed similar to the one for field corn should be made for sweet corn. The crop should not be planted until after field corn, for it is not so vigorous and grows slowly in a cold, wet soil. From four to five kernels are planted in a hill. Planting operations and cultivation are just the same as for field corn.

Harvesting and Marketing

Sweet corn is harvested much earlier than the field varieties. The harvest season is about a month in length, from the middle of August to the middle of September. Collins says that sweet corn is at its best about eighteen days after the silks emerge. The ears are snapped with the husks on and delivered directly to the canning factory. The time for this is directed by the factory, and it is important that the corn be gathered at about the right time. With the sweet corn crop there is no storage problem and no loss in shrinkage.

The customary yield on forty-bushel corn land is two and one-half tons of snapped corn to the acre. Prices for sweet corn vary greatly from year to year. However, Corn Belt canneries usually pay for a ton of the snapped corn delivered to the factory a price equivalent to fourteen to seventeen bushels of new corn. Of course, unusual weather, causing unusually cheap or unusually high dent corn prices, may vary this ratio, but one year with another these figures are about right for Evergreen corn. Ordinarily, the gross income from field corn and sweet corn grown on similar land is about the same. The higher value of sweet corn stalks, however, and the other incidental advantages make the real income from sweet corn usually greater than from dent corn.

Canning

Practically all the work of canning is done by machinery, from the time the corn is dumped on the scales until it is loaded on cars with labels attached. The corn is first husked, then the ears pass through a silker, and from there they go to the cutter. The cobs are ejected from the building, while the kernels pass on to the mixing vat, where salt, sugar and water are added in proper proportions. The corn then is fed into cans, which are capped and cooked in steam for an hour or two. Labeling and boxing usually are not done until after the rush season, or until time for the corn to be put on the market. A ton of ordinary Evergreen sweet corn yields about 672 cans, or 28 cases. With prices as they prevailed in 1923, with canned Iowa corn selling wholesale, per dozen, at 90 cents, it would seem that the Iowa canneries were selling the product of the average ton for about \$50. Of this, about \$15 rep-

resented the cost of the 672 cans. In addition, salt, sugar and other materials cost about $4, and labor amounted to perhaps $12. Overhead expenses were around $10 and the farmers were paid $9 a ton for their corn. The retail price is usually 45 per cent above the wholesale. When Iowa sweet corn retails at $1.30 a dozen, the Iowa farmer is paid about 23 cents out of this $1.30. The grower of the sweet corn seems to be only one small factor in a highly complicated process.

Table XV

Acreage, Yield Per Acre and Price Per Ton of Sweet Corn Grown for Manufacture, 1920-1922

(Bureau of Agricultural Economics, United States Department of Agriculture.)

	Acreage			Yield Per Acre			Price Per Ton		
	1920 (acres)	1921 (acres)	1922 (acres)	1920 (tons)	1921 (tons)	1922 (tons)	1920	1921	1922
Illinois	48,540	27,580	34,760	2.2	2.6	2.2	$19.75	$12.67	$ 9.77
Iowa	55,850	18,520	32,120	2.3	2.8	3.0	15.60	8.60	7.20
Maine	15,820	10,040	14,270	3.1	3.2	2.5	30.00	27.60	27.50
Ohio	30,970	13,790	20,310	2.0	2.5	2.2	18.67	10.29	5.70
New York	27,070	14,850	16,670	2.0	2.3	2.0	22.28	18.29	16.59
Maryland	24,590	14,660	22,260	2.6	2.5	2.6	23.00	11.70	10.00
Wisconsin	10,870	7,640	8,490	2.0	2.8	2.5	15.50	11.22	10.54
Indiana	15,080	9,180	13,730	2.5	2.9	2.0	18.50	12.00	10.00
Minnesota	11,860	7,700	11,660	2.5	2.8	2.0	15.00	10.40	9.14
Michigan	6,950	4,270	5,510	2.0	2.2	2.0	14.46	15.00	11.41
Delaware	3,000	1,570	5,540	1.8	2.0	2.7	15.60	9.00	10.00
Vermont	2,140	1,820	1,960	2.2	2.3	2.0	20.00	15.00	15.00
Pennsylvania	3,430	990	1,750	2.2	2.7	2.4	17.00	14.00	10.00
All other	9,900	3,190	5,690	2.2	2.9	2.0	13.55	12.98	8.07
Total	266,070	135,800	194,720	2.3	2.6	2.4	$19.28	$13.45	$11.09

Husk Pile Silage

Husk pile silage compares favorably with ordinary field corn silage. It is a valuable by-product of the canning factory, that is usually sold or given to the growers for feed. This silage is made up of husks, tips of ears, and cobs, which are high in protein and starch. The cobs are not as valuable as the husks and refuse ear tips. Husk pile silage ferments in the pile where it is dumped at the factory, and it need not be placed in a silo.

CHAPTER 29

VARIETIES OF CORN

ALTHOUGH there may be a thousand varieties or strains of corn, a few leading ones make up a large percentage of the corn grown. A few of the leading varieties in different sections of the Corn Belt are given in the following:

Section of Corn Belt	Leading Varieties
Northern	Silver King, Minnesota No. 13, Northwestern Dent, Wimple, Golden Glow.
Central	Reid Yellow Dent, Silvermine, Boone County White, Leaming.
Eastern	Boone County White, Reid Yellow Dent, Johnson County White, Leaming, Funk Yellow Dent.
Western	Reid Yellow Dent, Silvermine, Hogue Yellow Dent, Freed White Dent, Calico.
Southern	Reid Yellow Dent, Boone County White Dent, St. Charles White, Kansas Sunflower.

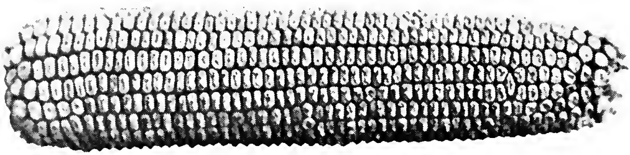
Reid Yellow Dent

Reid Yellow Dent was originated by an accidental cross between a rather late, light-reddish colored corn and a small, early yellow corn. Robert Reid, the originator, brought the reddish colored corn, known as Gordon Hopkins corn, to Illinois from Brown county, Ohio, in 1846. Because of a poor stand in 1847, a small yellow corn was used in replanting the missing hills, and so the cross occurred. James L. Reid, a son of Robert Reid, improved the hybrid by selection, his best work being done from 1870 to 1900. He won a prize with it at the World's Fair, in 1893, and as a result it soon became widely distributed.

Standard ears of this variety are nine to ten inches long and seven to seven and one-half inches in circumference, for the central Corn Belt, but vary somewhat with the section of the Corn Belt in which they are grown. The ear is slightly tapering, the rows are closely spaced, distinctly dove-tailed, and average from sixteen to twenty-two in number. The kernels are slightly keystone in shape, of medium depth and narrow to medium in width, with a square crown and a smooth to rough indentation. The normal color is yellow, but the reddish tinge of the Gordon Hopkins often appears. The cobs are inclined to be small and are dark red in color. The stalk is rather heavy, tall and leafy. The ears are often borne a little too high on the stalk unless care is taken in selection. The general opinion seems to be that Reid Yellow Dent can not be surpassed on rich soil where it has become acclimated.

Reid Yellow Dent requires from 110 to 120 days to mature and should be classed as medium late. At present, due to wide adaptability, it is the most common yellow variety in the Corn Belt, although the type necessarily has been modified to fit many different conditions. The type as now generally grown is rougher than the type which Reid originally preferred.

Outstanding strains of Reid corn are Iodent, Black, McCulloch and Krug. Iodent is an early Reid developed by L. C. Burnett, after years of painstaking ear-row work at the Iowa station. Black has resulted



Reid corn. (Rough type.)

from a cross of Iodent and a late show type of Reid, made by Clyde Black, of Dallas county, Iowa. McCulloch was produced by selection from a cross of a small amount of Pride of the North with a large amount of Reid. Fred McCulloch, of Iowa county, Iowa, was the originator. George Krug, of Woodford county, Illinois, in 1903, crossed Gold Mine with a Nebraska strain of Reid and has developed Krug corn by selecting continuously for a smoother, rather small-eared type. All of these strains have demonstrated their ability to yield. (See Chapter 36, on Corn Yield Contests.)

Boone County White

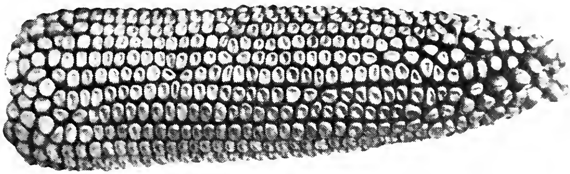
Boone County White was originated in Boone county, Indiana, by Mr. James Riley. In 1876, he obtained his foundation stock, which was a large, coarse, late-maturing variety of corn known as White Mastodon. The stalk is heavy and rank, with short inter-nodes and abundant foliage. The ideal ear is nine and one-half to ten and three-fourths inches long and seven and one-half inches in circumference. The shape is nearly cylindrical, with straight rows, sixteen to twenty-two in number, and of medium spacing. The butts are rather large and open with shallow cavity. The cob is white and is rather large and heavy. The kernels are thick and blocky, medium to wide, and medium to deep. The normal color is a creamy white and the usual indentation is rather rough.

Boone County White is a late-maturing variety of corn, requiring 120 to 125 days. It is grown chiefly in the southern Corn Belt, and on account of its late maturity is not well adapted to the remainder of the Corn Belt. However, it is a popular corn on the rich land of

the sections where it is adapted. Boone County White and the related Johnson County White are far more widely grown than any other white Corn Belt varieties.

Leaming

Leaming corn has been developed since 1856, according to W. A. Lloyd, of the Ohio station. It did not originate in 1826. Mr. Lloyd says: "Manifestly, J. S. Leaming could not, as it is often stated, have originated this corn at that time (1826)." J. S. Leaming, in developing Leaming corn, placed special emphasis on early maturity. He



Leaming corn (original type, as favored by Mr. J. S. Leaming).

thought that a rather short stalk, heavy at the butt and tapering rapidly, bearing a tapering ear, was the type that matured earliest. The original Leaming corn ripened in from 90 to 100 days.

The present day type of stalk is still medium in height. The ideal ear is nine to ten and one-half inches in length and seven to seven and three-fourths inches in circumference, with large, rather open butt and distinctly pointed tips. The rows vary from sixteen to twenty-four in number. The kernels of true Leaming are medium in depth, very thick and rather narrow. Leaming is a deeper yellow than most yellow dents. The indentation varies from smooth to rough, but in the original Leaming the smooth type was preferred.

It is grown most extensively in the central and eastern parts of the south-central Corn Belt and to some extent in adjoining sections of the north-central Corn Belt. Leaming became popular in the eighties and nineties, partly because of the publicity it received from winning prizes at the World's Fair in Paris, in 1878.

Silvermine

Silvermine originated with J. A. Beagley, of Sibley, Illinois, who started with a sample of white corn which won a prize at the Ford county, Illinois, institute in 1890. The Iowa Seed Company, of Des Moines, bought his entire crop in 1895, for $1,000, and originated the name, Iowa Silvermine.

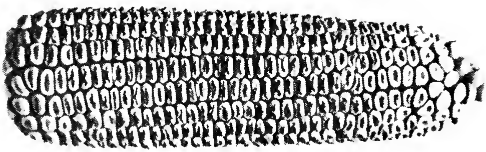
Silvermine is not a rank-growing variety, and even on rich soil it does not produce as heavy foliage as some varieties. The stem is of a fine texture and there is little coarseness about the joints. The ears are

medium in size, being from nine to ten inches in length and from seven to seven and one-half inches in circumference. They are cylindrical for about two-thirds of the length of the ear and then slowly taper off at the tip. The kernels are of medium depth and width, but thin in comparison with their width. The dent varies from smooth to rough. The color is creamy white. The deep kernel and small cob of Silvermine give it a high shelling percentage.

Silvermine is adapted to a wide range of climate and soil and has the reputation of doing well on poor soils. It is a medium early corn, maturing in 110 to 115 days, and is well adapted to central Corn Belt conditions. It is the leading white variety just north of the section where Boone County White is widely grown.

Silver King

Silver King, also known as Wisconsin No. 7, was first developed as a variety by H. J. Goddard, of Fort Atkinson, Iowa, who brought a bushel of the seed from Indiana to Fayette county, Iowa, in 1862. Mr. Goddard selected for early maturity and yield. To improve the yield, he selected fairly large ears with deep, wide kernels, a medium to small cob and closely spaced rows. One of the valuable characteristics of this



Silver King.

corn is its freedom from barren stalks. The ideal ear is eight to nine inches long and six and three-fourths to seven and one-half inches in circumference. There is a gradual taper from butt to tip, and the rows average sixteen to the ear and are inclined to be wavy. Silver King has creamy white kernels which are very wide, of medium depth and thickness, slightly keystone in shape. The usual indentation is rough. It is one of the earliest maturing of the prominent varieties, maturing in 100 to 110 days. It ranks first in importance in the northern Corn Belt and stands next to Reid Yellow Dent in the north-central parts. Some Silver King is grown as far south as Missouri, but only for late planting or replanting.

Kansas Sunflower

Kansas Sunflower originated from an early yellow variety of corn introduced from Iowa into Douglas county, Kansas, in 1887. John Moody, of Eudora, Kansas, obtained seed of this variety in 1890, and continued growing it for some time, carefully selecting the seed each

season. Five years later he sold his entire crop to the Barteldes Seed Company, of Lawrence, from whence it was distributed under the name of Kansas Sunflower.

The stalks grow from eight to nine feet in height, are fairly leafy, and under favorable conditions sucker rather badly. The variety is a hardy and vigorous grower. The ideal ears are nine to ten inches in length and seven inches or slightly less in circumference. The ears are rather slender and taper slightly, carrying ordinarily fourteen to eighteen rows of kernels. The kernels are broad, medium deep and of medium indentation. The grain of Kansas Sunflower is a bright, rich yellow.

Kansas Sunflower is a medium late variety, which ripens in 120 to 125 days. It is well adapted for growing throughout eastern Kansas. Because of the slender ears and lack of show characters, Kansas Sunflower has not been a very popular variety, even though it has consistently given good results.

St. Charles White

The St. Charles White is a native of St. Charles county, Missouri, where it has been grown for a great many years. Two types of this corn are recognized—the small St. Charles and the large St. Charles, the former being slightly earlier and better adapted to thin lands.

The ears taper somewhat from butt to tip. The cobs possess the striking peculiarity of being blood-red in color. The St. Charles White is a late-maturing variety, averaging 125 to 130 days for complete maturity. It is a rank-growing variety with adaptation similar to Boone County White. It is useful as a silage variety.

Commercial White

The Commercial White corn was originated by P. E. Crabtree, of Barton county, Missouri, who developed the corn by selecting the white cobbed ears of the St. Charles White. The ideals which have been kept in mind in selection are uniform kernels of medium depth, with a low amount of crown starch and large germs.

The ears are larger in circumference and more cylindrical than are those of the St. Charles White, but often taper quite abruptly at the tip. The rows are straight and distinctly paired. The butts have a tendency to be flat and often have a large shank. The kernels are broader than those of St. Charles White and are only of medium depth. They are thick and a trifle more wedge shaped than the St. Charles White and more rounded at the top. They possess a small amount of crown starch and are pearly white in color. The indentation is medium smooth.

Commercial White is a late maturing variety which requires 125 to 130 days for complete ripening. It is a tall growing corn, averaging about nine feet for the state, and very leafy. The stalks are very strong and stocky. The cob, which has a tendency to dry slowly, prevents as high a grade of market corn as either Boone County White or St. Charles

White. It is a good silage variety. Missouri co-operative tests have shown it to be the highest yielding variety on the black prairie uplands of the state.

Minnesota 13

Minnesota 13 was originated by ear-row breeding at the Minnesota experiment station, from seed purchased in 1893, from a St. Paul seed company. Probably it was from Pride of the North. The ideal ears are seven to eight inches long and six and one-half inches in circumference. There are twelve to sixteen rows and the ears are slightly tapering. It has yellow kernels and a red cob. The kernels are shallow and have a dimpled dent. It is an early-maturing but heavy-yielding variety, adapted to the region extending from southern Minnesota northward.

Golden Glow

Golden Glow, which is the most popular yellow dent in Wisconsin, was originated by the Wisconsin station by crossing a Wisconsin strain of Minnesota 13 with a somewhat later and larger-eared variety long grown in Wisconsin under the name of North Star. After several years of selection, the new variety was distributed by the Wisconsin station.

Hogue Yellow Dent

Hogue Yellow Dent has been grown by Mr. R. Hogue, of Crete, Saline county, Nebraska, since 1885. He obtained the corn from Lancaster county, Nebraska. The history of the corn previous to that time is not known. Mr. Hogue has carefully selected the seed each year, having particularly in view a deep kernel. The result is an ear with rather deep kernels, deeply indented and fairly late maturing. One characteristic of the corn is a thick, medium tall stalk with long, broad leaves, giving a large amount of foliage. The variety has never been intentionally crossed since Mr. Hogue obtained it. Mr. Hogue has never undertaken to select for uniformity of kernel type or ear; in fact, he has always intentionally selected and mixed several ear types for his seed supply.

The standard for type adopted by the Nebraska Corn Improvers' Association is: Shape of ear, slightly tapering; length of ear, eight to nine inches; circumference of ear, seven to eight inches; color of kernel, yellow; shape of kernel, wedge; indentation of kernel, rough; number of rows, sixteen to twenty; size of shank, medium; size of cob, medium; color of cob, red.

The variety requires approximately 120 days to mature and is not well suited under conditions of a shorter growing season. It is extensively grown in eastern Nebraska and central Kansas.

Johnson County White

Johnson County White was originated by J. D. Whitesides, in Johnson county, Indiana, in 1893, from a cross between Boone County White and Forsythe's Favorite, and was improved by several farmers.

The ideal ears are about nine and one-half to ten and one-half inches long and seven and one-half inches in circumference. They are about the same size as Boone County White, but are slightly more tapering. The kernels are narrower and more nearly square at the crown than Boone County White. They are also deeper, rougher and more starchy in composition, which gives them a starchy white color.

Johnson County White matures in 120 to 125 days, and is adapted to the southern Corn Belt, but is too large and late maturing north of southern Iowa. It is replacing Boone County White in many localities.

Freed White Dent

This variety was developed by J. K. Freed, of Scott county, Kansas, who began by selecting a badly mixed variety of a local corn for the purpose of establishing a more uniform type of ear and kernel. The original source of the foundation stock is unknown. The corn has been grown in western Kansas for at least thirty years.

Freed White Dent ranges in height from six to eight feet, depending on the growing conditions. The stalks are sturdy, fairly leafy, and are likely to sucker extensively under favorable conditions, but not to so great an extent as most other western developed varieties. The ideal ears are seven to eight and one-half inches long and six and one-half to six and three-fourths inches in circumference. The number of rows of kernels varies from twelve to sixteen. The kernels are rather shallow and medium in width and thickness. The dent is smooth and the kernel texture is flinty.

Freed White Dent is an early variety, which matures in 105 to 110 days. It is primarily adapted for growing in western Kansas and on the uplands in west-central Kansas. Because of its hardiness and vigorous growing habits, it is an exceptionally high-yielding early corn for growing anywhere in Kansas.

Northwestern Dent

The origin of Northwestern Dent is doubtful, but almost certainly was the result of crossing a dent and a flint, one of which was red. It is a semi-dent variety that normally produces more suckers and leaves than any other common dent. The ear is six to nine inches long with ten to fourteen rows of kernels. The kernels are red with a white or yellowish crown. It is a hardy corn adapted to the extreme northern part of the Corn Belt, and is the best known variety in the northwest.

Wimple Yellow Dent

Wimple Yellow Dent was developed by Mr. Wimple, of Beresford, South Dakota. The ideal ears are eight to nine and one-half inches in length and tapering in shape. The kernels are wide with a short beak dent and are lemon yellow in color. It has a larger ear and considerably heavier stalk than Silver King. Wimple Yellow Dent matures in from

105 to 115 days. It has been grown in the northern part of the Corn Belt for a number of years. The originator has recently developed a smoother, earlier strain.

Funk Yellow Dent

Mr. Funk, of McLean county, Illinois, secured the original seed from Mr. James Reid, about thirty years ago. Since that time, popular opinion has demanded several variations in type. For a time, it was bred for a rough type, but in recent years the emphasis has been on the smooth.

A popular utility type of corn is Funk Yellow Dent, Strain 176-A. The ideal ears are nine to eleven inches long and seven to eight inches in circumference. This variety conforms just as nearly as possible to the utility type score card. The story of how this strain of corn has been developed from Funk Yellow Dent is as follows:

"In germinating several hundred bushels of seed corn during the winter of 1915 and 1916, we occasionally noted a few ears on the germinator that were remarkably free from molds and rotting and that possessed unusual vigor and magnificent root development. These ears proved their superiority in the field during the following season, by far outclassing everything else in the experimental plots. The progeny from these champion mother ears have been multiplied and improved further by special breeding methods."

Calico

Strains of Calico have been developed by different growers. The shape of the kernel, dent, character of stalk and length of growing season vary considerably, depending upon the grower. The ears are from nine to eleven inches long and almost cylindrical. The kernels are variegated in color, ranging from pink to red, depending upon the amount of red in the striping, but there are sometimes groups of kernels of solid white, red or yellow. It is quite widely distributed and has no fixed characteristics. Many strains are early to medium maturing. These are well adapted to western Corn Belt conditions.

Bloody Butcher

Bloody Butcher is a name applied to strains having a deep red grain. The crown of the kernel varies in color for the different varieties, but is usually lighter than the remainder of the kernel. As a rule, Bloody Butcher corn is not any more productive than corn of any other color. Like Calico, the different varieties of Bloody Butcher vary greatly, as do those of the white and yellow varieties. The red color is in the hull only; beneath the hull, some Bloody Butchers are white and some are yellow.

Several of the important varieties in addition to the ones just described are as follows:

Early White Dent

Marten White Dent (Great Plains); Payne White Dent (Great Plains); Pioneer White Dent (Northwest); Rustler White Dent (Northwest), and Webber Early Dent (Great Plains).

Medium to Late White Dent

Brazos White (Texas); Champion White Pearl (Illinois); Chisholm (Southwest); Cob Pipe or Collier (Missouri); Democrat (Illinois); Easterly White (Illinois); Eureka (general); Farmer's Pride (eastern Corn Belt); Farmer's Interest (eastern Corn Belt); Faulkner (Illinois); Forsythe (Kansas); Hammett (Kansas); Iowa Ideal (Iowa); McAuley (Kansas); Mexican June (Southwest); Munikhuysen (Southeast); Nebraska White Prize (Nebraska); Pride of Saline (Kansas); Roseland (Kansas); Shawnee White (Kansas); Sherrod White Dent (Kansas); Surcropper (Southwest); Tuxpan (Southwest); Vogler White Dent (Indiana), and White Wonder (Oklahoma).

Early Yellow Dent

Ardmore Yellow (South Dakota); Brown County Yellow (Northwest); Golden Surprise (Ohio and Illinois); Kossuth County Reliance (Iowa); Minnesota King (Minnesota); Murdock (Wisconsin); Pride of the North (general), and Robertson Yellow Dent (Northwest).

Medium to Late Yellow

Bear Paw (Ohio); Cartner (Missouri); Champion (Ohio); Clarage (Ohio); Cuppy (Ohio); Darke County Mammoth (Ohio); Early Yellow (Indiana); Ferguson (Southwest); Giant Beauty (Southeast); Golden Beauty (Missouri); Golden Eagle (Illinois); Golden Gem (Southeast); Golden King (Illinois); Goldmine (general); Hiawatha (Kansas); Hildreth (Kansas); K. B. Yellow Dent (Iowa); Lancaster Sure Crop (Pennsylvania); Legal Tender (general); Midland Yellow (Kansas); Monitor (Ohio); Riley Favorite (Indiana); St. Charles Yellow Missouri; Shroll Yellow Dent (Ohio); Skipper (Southeast); Wabash Yellow (Indiana); Western Plowman (Illinois), and Yellow Jumbo (Ohio).

Miscellaneous Dent

Blue and White (scattered); Devolid (Ohio); Early Red (scattered); Hackberry (Ohio); Hecker Red (Illinois); Lenocher Homestead (Iowa); Minnesota 23 (Northwest); Old Glory (Texas); Rotten Clarage (Ohio); Strawberry (general); Stony Hill White Cap (New York); Strout Red (Illinois); Swadley (Great Plains), and White Cap Y. D. (general).

Cotton Belt Single Ear

Lowman (yellow); Shenandoah White (white); Southern Beauty (white); Wyatt Improved (yellow); Hickory King (white).

Cotton Belt Prolific

Bigg Seven Ear (white); Cocke Prolific (white); Garrie (white; Hasting Prolific (white); Hickory King (white); Jarvis Golden Prolific (yellow); Marlboro Prolific (white); Mosby (white), and Sanders (white).

New England Flints

Hall Gold Nugget; King Philip; Longfellow; Mercer; Rhode Island; Sanford White; Smut Nose.

Northwestern Flints

Assiniboine; Burleigh County Mixed; Cassia County; Dakota White; Fort Peck Indian; Gehu.

Southern Flints

Creole.

Argentine Yellow Flints

Canario; Colorado, and Piamontese.

Italian Yellow Flints

Cinquantino; Nostrano Isola; Pignoletta d'oro; Rostrato, and Scagliolo.

Soft Corn

Ivory King; Mixed; Rea, and Brazilian Flour.

CHAPTER 30

DEVELOPMENT OF THE PLANT

THE two steps in the development of the corn plant are first, germination, and second, growth. The essentials of these two steps in development are discussed in this chapter.

Germination

The four conditions necessary for seed to germinate are (1) vitality, (2) moisture, (3) heat and (4) oxygen.

Under favorable conditions, corn may retain its vitality for ten years. However, after the second year of storage, the vigor of germination rapidly declines. As a practical proposition, seed corn should never be kept past the second year.

Moisture is necessary for seeds to germinate. Water readily penetrates and softens the seed coat of corn.

Corn requires a higher temperature to germinate than the small grains. It is a crop which germinates best under higher temperatures than usually prevail in May. Doctor Pammel, of the Iowa station, gives the following temperatures for the germination of corn: Minimum, 49.9 degrees F.; maximum, 134.8 degrees F.; optimum, 91.4 degrees F. Cold-resistant strains of corn are being developed which will germinate when the temperature is as low as 43 degrees F.

Oxygen is found in the seed, but not enough for germination. One of the reasons that corn does not germinate well on poorly drained soils is that the excess water in the soil excludes oxygen.

Growth

Growth is cellular development. During early development, growth takes place in all parts at the same time, and after the first three weeks of growth all parts of the plant are formed. The five essentials for the growth of the corn plant are (1) vigor, (2) water, (3) light, (4) heat, and (5) plant food.

The plant must have inborn vigor. A seed may sprout, but if the seedling does not have strength, a normal plant will not be obtained.

Water

Corn requires large quantities of water to carry plant food and to keep it from wilting. Kiesselbach found that the rapidity of transpiration of corn varies directly with the temperature and the leaf area. A well-grown corn plant on a hot day in late July will transpire five to ten pounds of water. This means that an acre of corn plants at this time of year is pumping up water from below and throwing it into the atmosphere at the rate of eighteen tons daily, or 720 tons of water per acre for the forty days during July and August when the corn is most active.

Light

Light furnishes the power which all green plants require. The process by which green plants take sunlight and store up its power is known as photosynthesis (light-building). In photosynthesis the carbon dioxide of the air enters the leaves through stomata (little holes) and is there combined by the power of the sunlight with water to make formaldehyde and later starch. Starch is literally imprisoned sunshine. Of all green plants, corn is one of the most efficient in capturing sunlight in large quantities and storing it away in the form of starch.

Heat

Corn requires a large amount of heat for development. In a Pennsylvania experiment, it was found that during the twenty-two days preceding tasseling, those days with a mean temperature of less than 70 degrees F. usually resulted in a growth of three to three and one-half inches in twenty-four hours, whereas those days with a mean temperature of 75 or more degrees resulted in a growth of five to five and one-half inches in twenty-four hours. When the temperature in the daytime exceeded 85 degrees, further increases did not seem to result in greater growth, probably because of moisture shortage.

Plant Foods

A fifth essential for growth is plant food. In general, corn requires the following chemical elements: Carbon (C), hydrogen (H), oxygen (O), phosphorus (P), potassium (K), nitrogen (N), sulphur (S), calcium (Ca), iron (Fe), magnesium (Mg). The expression, "C.HOPK(i)NS CaFe Mg (Mighty Good)" is a reminder of the essential chemical elements.

Oxygen, carbon and hydrogen are furnished by air and water, whereas the other elements are minerals in the soil. About 97 per cent of the corn kernel comes from the air and only 3 per cent from the soil. Each element is a specialist in its own field, and should it become deficient can not be replaced by another.

Oxygen is the most abundant element. It readily forms compounds with practically all other elements and constitutes about one-half of all known matter. It enters the plant in the compound, CO_2, a gas, and H_2O, water, where it is further changed by sunlight to build up the carbohydrates and proteins. The corn kernel is about 46 per cent oxygen.

Carbon is closely associated with plant life. It enters the leaves of the plant in the form of CO_2, where it is combined by sunlight with water brought up from the roots to form sugar, starches and the like. Carbon composes 45 per cent of the corn kernel.

Hydrogen is the third most abundant element in the corn kernel. It makes up 6.4 per cent of the corn kernel. Water is the one important source of hydrogen for plant growth. This element is combined by sunlight with carbon and oxygen to form the various carbohydrates and proteins within the plant.

Nitrogen is one of the most important and possibly the least appreciated elements. It forms one-sixth of the protein in plants, the formation of which would be stopped without it. Nitrogen:

1. Stimulates growth of foliage.
2. Imparts a deeper green color to foliage.
3. Delays the maturing process.
4. Controls the amount of other plant foods used.

About 1.5 per cent of the corn kernel is nitrogen.

Sulphur is an important constituent of both protein and protoplasm. There is practically always a great abundance of sulphur in the soil. About one-fifth of one per cent of the corn kernel is sulphur.

Phosphorus is found in every cell of every plant, but it is especially abundant in the seed. It is of great value because it:

1. Causes rapid germination of seed.
2. Causes early ripening.
3. Causes greater formation of seed in proportion to stem.
4. Is essential to protoplasm.

About one-third of one per cent of the corn kernel is phosphorus.

Potassium plays an important role in the development of plant life. It seems to:

1. Encourage carbohydrate formation.
2. Aid in transference of starch.
3. Aid the plant in resisting fungus disease.

About one-third of one per cent of the corn kernel is potassium.

Calcium, which is fundamental both to plant and animal nutrition:

1. Aids in the development of root hairs.
2. Aids in the transportation of starch.
3. Neutralizes plant acids.
4. Has a strengthening effect on cell walls.

The corn kernel contains less than one-tenth of one per cent of calcium.

Magnesium is found more particularly in the seed of plants. In this respect, it is the opposite of calcium. Practically all soils contain sufficient magnesium for plant growth. About one-seventh of one per cent of the corn kernel is magnesium.

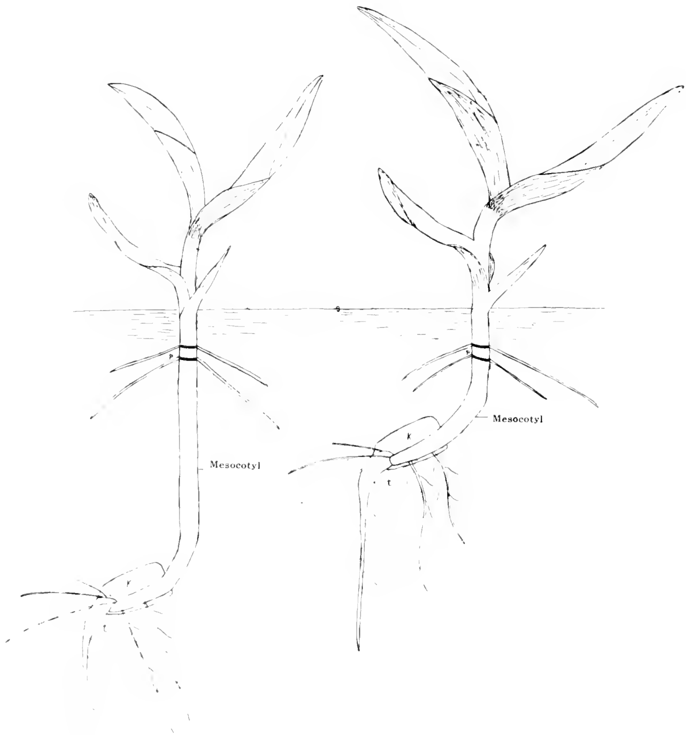
Iron is second to oxygen in abundance in the earth's crust. It is never a limiting factor in production, as plants use only a small amount of it. Nevertheless, iron is essential to chlorophyll production. By withholding iron from plants, no chlorophyll will develop, and consequently the plant makes no natural growth. Only small traces of iron are found in the corn kernel.

Of these ten essential elements, there are two, phosphorus and calcium (lime) which must be purchased and added to the soils of the Corn Belt to keep them productive. The other eight elements are either present in abundance already or can be maintained through certain natural processes.

CHAPTER 31

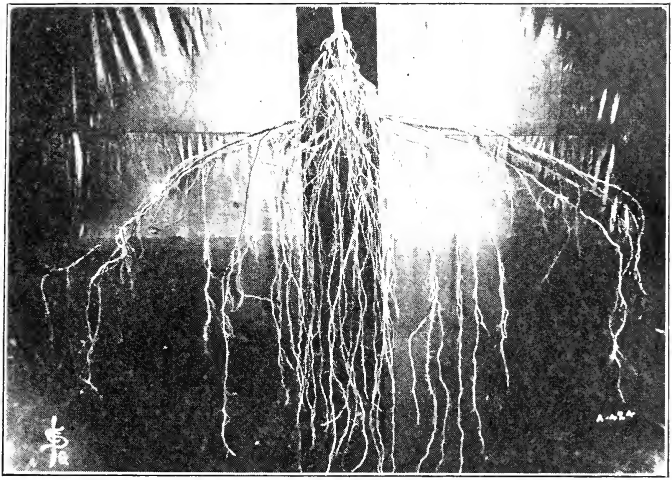
BOTANICAL CHARACTERISTICS OF CORN

CORN, like other grasses, has a fibrous root system. The three types of corn roots are (1) temporary, (2) permanent and (3) brace roots.

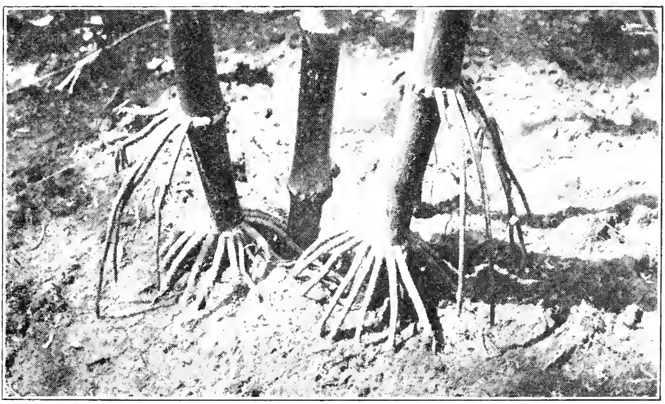


Illustrating how depth of planting influences length of mesocotyl and why the permanent roots (p) start just below the surface of the ground, no matter how deep the kernel is planted. The temporary roots (t) lose their importance after the permanent roots are well established, except possibly in the case of Hopi corn.

The temporary root system is composed of the roots which are pushed downward from the tip of the kernel when it first sprouts. During the first two or three weeks after germination the temporary roots furnish most of the food which the young plant obtains from the soil.



The root system of corn is much more extensive than most people suspect. This picture shows only a part of the roots. The great mass of fine roots are lost on digging. (Courtesy of Iowa Station.)



Brace roots.

Later on, these roots either rot away from the plant or become unimportant except in the case of Hopi corn, which seems to rely on the temporary roots to bring up moisture from the deeper layers of the soil.

If the young corn plant, two or three weeks after germination, is dug up, it will be noted that between the kernel and the green stem above ground is a slender white stem. This is known as the mesocotyl. In the case of corn planted one inch deep, the mesocotyl is about one inch long, whereas in the case of corn planted twelve inches deep (Hopi corn is often planted this deep), the mesocotyl is twelve inches long. The temporary roots start from below the mesocotyl and go downward, whereas the permanent roots start from just above the mesocotyl.

Corn occasionally sends out branches from the upper nodes. This is common in teosinte and certain types of tropical corn.

Permanent Roots

The first two, three or even four nodes of the mature corn plant are separated by very short inter-nodes and are just below the surface of the ground. It is from these nodes just below the surface of the ground that the permanent roots start out laterally from the nodes and then go downward to a depth of as great as five or six feet. The large, strong permanent roots are concentrated within a foot or two of the plant and only the small, fibrous roots reach the greater depth.

Brace Roots

Brace roots differ from the permanent roots in that they come from the first two or three nodes above ground. In "down" corn or certain tropical varieties the brace roots may come out from nodes as high up as the fifth or sixth. Brace roots from the first node or two above ground are of very real help in maintaining an upright corn plant, but it is doubtful if brace roots from the higher nodes serve any useful purpose. Funk says they are associated with diseased corn. The stem of each inter-node is hollow on one side and it is on this hollow side that the leaf comes out. From the lower nodes on this hollow side there usually develops a small bud which does not amount to much except in the cases of the nodes which bear ears.

The roots of the corn plant:

1. Support and anchor the stalk.
2. Absorb plant food (soluble salts and water).

3. Excrete organic substances (such as carbon dioxide, mineral salts and organic acids).
4. Render plant food soluble by action of the excretions.

Root growth is increased when the following conditions are present:

1. Large supply of oxygen.
2. Favorable temperature.
3. Plenty of moisture.
4. Good soil tilth.
5. Abundant available plant food.

Stalks

The stalks of corn vary in height from one and one-half to about thirty feet. Some of the small, early popcorns will develop ears when only one and one-half feet high. Silage corns often make a growth of eighteen feet.

The stalk is made up of nodes or joints, usually eight to twenty in number. The average number of nodes is about fourteen. In typical dent varieties of the central Corn Belt, the eighth node as a rule bears the ear. The node is the origin of all lateral outgrowths, such as roots, branches, leaves and ears. The portion of the stalk between the nodes is called the inter-node. The longer inter-nodes are toward the top and the shorter toward the base

In cross-section, the stalk is made up of four parts, as follows:

1. The epidermis, a thin transparent tissue, covers the outer part of the stalk. It is impervious to moisture and protects the stalk from insects and disease.
2. Just beneath the epidermis is the stem wall—a woody layer, the hard, stiff portion of the stalk, made up of large numbers of fibro-vascular bundles, closely packed together. These bundles, stiffened by silica deposits, make the stem wall the "backbone" of the plant.
3. The center cavity of the stalk is filled with pith. It is a soft, spongy mass of tissue and serves as a storehouse for moisture and food. The fibro-vascular bundles in the pith are separated by large masses of pith.
4. The fibro-vascular bundles are channels for the transportation of plant food. They are found mostly in the woody stem wall and extend from the roots up through the stalk to the leaves and ears. They carry mineral plant food from the roots to the leaves and manufactured plant food to the ears and stalk. A little food is manufactured in the stem as well as the leaves.

Length growth takes place just above the nodes, and at the end of the stalk. The growth may be likened to a telescope. As a telescope unfolds, so does the corn stalk unfold. Therefore, the statement that we can "see corn grow over-night" is often made. Diameter growth takes place from the inside and not by added layers as in a tree. This type of diameter growth is called endogeneous.

Suckers

Suckers, or tillers, are branches which come from the nodes just at or just beneath the surface of the ground. The tendency to sucker is influenced by the variety, soil conditions, rate and method of planting.

A large amount of available plant food will produce more suckers than soil in poor condition. Plentiful moisture increases the number of suckers.

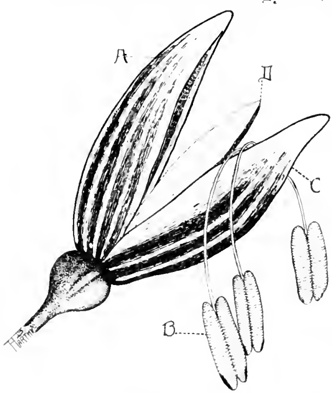
Corn planted one kernel to the hill will send out more suckers than when planted at the rate of five kernels. Suckers have their own root system and often bear ears. However, the ears as a rule are inferior to those upon the main stalk, often being borne on the tassel. It does not pay to pull off the suckers. At the Nebraska station, they found that pulling off suckers cut the yield greatly.

Leaves

The leaves on a corn plant are arranged alternately, conceal the grooved sides of the stalk, and are usually twelve to eighteen in number. The wavy margin, the result of the outside growing faster than the mid-rib, adds surface and flexibility to the leaf. The corn leaf is made up of three parts, as follows:

1. Leaf sheath. It comes from the node, and clasps or surrounds the stalk.
2. Blade, often incorrectly called the leaf. It is composed of the mid-rib, veins (parallel to mid-rib) and intracellular tissue.
3. Ligule, located at the hinge between the sheath and the blade. It is a collar which prevents water, dirt and insects from running down the sheath and stalk At either end of the ligule is situated the auricle, or lobe-like portion. It is the light-green, wavy, triangular portion of the blade. It turns the water down the stalk onto the leaf below.

The leaves use the energy of the sunlight to manufacture plant food from water, minerals and carbon dioxide, and give off excess moisture.



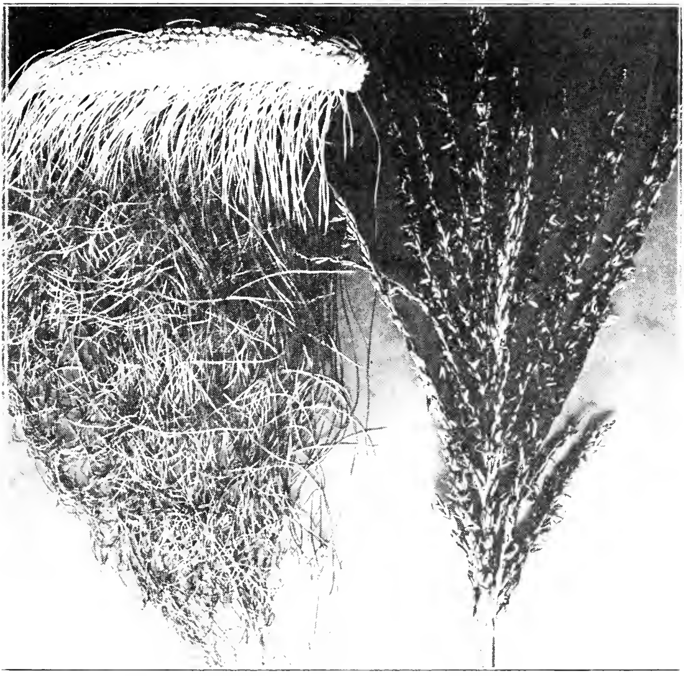
Staminate or male spikelet as borne by the corn tassel. (a) Upper flower, which has not yet opened enough to show anthers; (b) anther of the lower flower; (c) empty glume; (d) palea.

Flowers

The male and female flowers of corn are located in spikelets on different parts of the same plant. This flower arrangement makes cross pollination and fertilization the general rule in corn. It is estimated that not more than five per cent of corn grown under field conditions is selfed (pollen falls on silk and fertilizes ovule of the same plant). Kiesselbach found less than one per cent of self-fertilization under ordinary Nebraska conditions.

The male flowers are located in spikelets on the tassel of the plant. Each spikelet contains two flowers and each flower has three anthers.

which contain the golden colored pollen. There are about 2,500 pollen grains in each anther, and there are about 7,500 anthers in each tassel. Therefore, each tassel may furnish about 20,000,000 pollen grains. This number is far in excess of the pollen required, because only one pollen grain is needed to fertilize a flower and develop a kernel, and an ear requires only from 800 to 1,000 pollen grains to fertilize the female flowers.



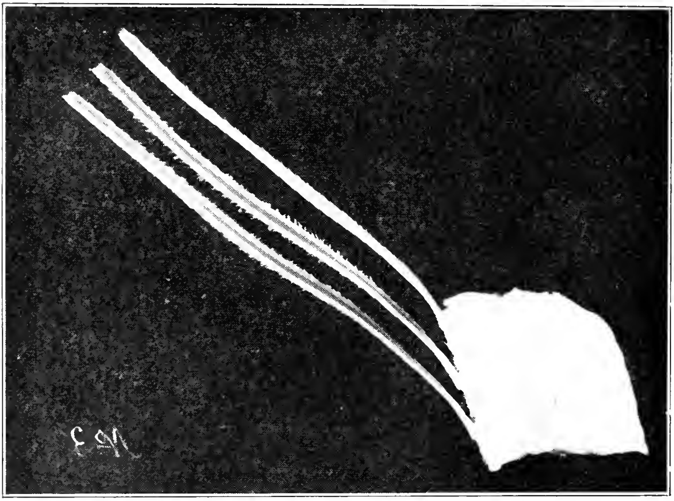
Female or pistillate corn flower (green ear shoot without husks, but with silks) on the left. Male or staminate corn flower on the right.

There are therefore 20,000 pollen grains produced for each female flower. The pollen is carried by the wind, and occasionally pollen may be blown half a mile. There is, however, much less mixture between fields than is commonly thought. Pollen ordinarily retains its vitality for about twenty-four hours. It may be killed in a few hours by heat and drouth.

The tassel, as a rule, emerges before the silks do, and so pollen is available from one to three days before it is needed. Kiesselbach says: "Extensive observations have shown that in general the pollinating

period of the tassel materially overlaps the silking period. Self-pollination might occur extensively were it not for the overwhelming preponderance of foreign pollen scattered promiscuously through the air."

The female flowers are located in pairs on the cob. Only one flower of each pair develops. An exception is the Country Gentleman variety of sweet corn, in which both flowers develop. An average ear of corn will have about 800 developed female flowers. Each of the



Illustrating how each unfertilized ovule on the young shoot has a silk (style) growing from it.

flowers sends out a silk (style), and it takes from two to four days to send out all the silks. The kernels near the butt end of the ear send out their silks first. The end (stigma) as well as the surface of the silk is hairy and mucilaginous, to aid in catching the pollen grains. These silks are receptive to pollen before they emerge from the husk, and if they are not fertilized, they remain receptive for about two weeks.

Fertilization

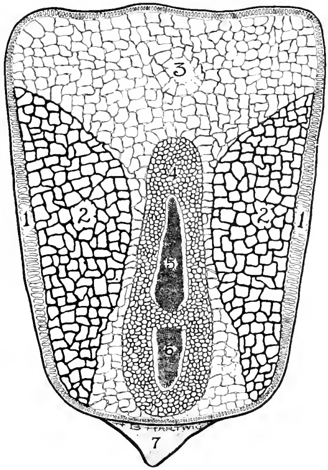
Kiesselbach says: "Every kernel has its own silk and must be fertilized separately. In the process of fertilization, pollen falling on the silk germinates and grows a pollen tube through the silk to the kernel, to which it conducts the two sperm nuclei. One of these nuclei fuses with the egg nucleus to form the initial embryo nucleus, (true fertilization), and the other with the two polar nuclei, forming the initial endosperm nucleus (causing xenia. See Chapter 34). This entire process has been found to be completed within approximately twenty-

four hours' time. Fertilization is reflected in the discoloration and drying of the silks in from forty-two to seventy-two hours after pollination."

Ear Compared With Sucker

The ear, including the shank and husks, may be likened to a branch or sucker of the main stalk. Each ear shank contains as many nodes as the stalk bears above the ear. The nodes of the shank occasionally bear several small ears in addition to the main ear. Each husk represents the leaf sheath, and the streamer often found toward the top of the husk is comparable to the leaf blade. The cob is analogous to the tassel, in that it is a central spike which bears flowers. However, except in the case of freak ears, the cob has no lateral branches. Theoretically, each row of corn corresponds to a spike and the entire ear is a combination of a number of spikes which have grown together.

As a rule, Corn Belt varieties mature but one good ear of corn upon one stalk. Prolific varieties mature several ears upon one stalk.



Typical kernel of dent corn. (1) Aleurone layer, which is colorless and almost impossible to detect with the naked eye, except in blue and a rare type of red corn; (2) horny or hard starch, which is colorless except in yellow corn; (3) soft starch, which is white in all colors of corn; 4, 5 and 6 together are the germ, 4 being the scutellum, 5 the plumule and 6 the radicle; (7) tip cap.

Kernel

The kernel is ripe in the ordinary season about fifty days after fertilization. Twenty days after fertilization the kernel is ripe enough to germinate, although it has only reached the milk stage by this time.

Stages of ripening are:

Milk stage—starch in the form of a fluid (about twenty days after fertilization).

Soft dough—starch soft and cheesy (about thirty-five days after fertilization).

Hard dough—starch hard and firm (about forty-two days after fertilization).

Ripe (about fifty days after fertilization).

The kernel may be divided into six parts, as follows:

1. Hull—the thin covering which encloses the entire grain. The hull is nearly colorless in commercial varieties except in red and calico corn.

2. Aleurone layer—a thin layer just beneath the hull. This layer is colorless and difficult to distinguish except in blue corn and a rare dull-red type. The red aleurone type is never grown commercially.

3. Soft starch—large, loose starch cells that occupy the crown and often the back and a part of the germ end of the kernel. It is often called white starch. In soft or flour corn, nearly all the kernel except the germ is soft starch.

4. Hard starch—small, compact starch cells and protein bodies occupying the sides and back of the kernel. It is translucent, whereas soft starch is opaque. In flint corn nearly all of the kernel except the germ is hard starch. The color of yellow corn is found solely in the hard starch, which means that yellow flint varieties are usually far deeper in color than either the soft or dent varieties. The hard and soft starch together make up what is commonly called the endosperm.

5. Germ—oily portion occupying most of the front side of the kernel. Composed of three parts, plumule, radicle and scutellum (or cotyledon). The plumule develops into the stem sprout and permanent roots. The radicle develops into the temporary roots. The scutellum absorbs changes and transfers plant food for the seedling.

6. Tip cap—affords attachment of the kernel to the cob and protection to the germ. It is usually retained by the kernel in shelling. When broken off, it exposes the black covering of the germ. This covering is natural and not an unsoundness. Botanically, the tip cap is a bract which in the ancestors of corn almost completely enclosed the kernel.

CHAPTER 32

CORN BREEDING

SPECIAL corn breeding methods do not pay on the average farm. Most farmers who have a good, acclimated variety are justified in doing nothing more than picking well-matured, solid ears, free from mold, every fall before frost. In addition, it may be well to see that the ears come from stiff stalks and are borne at a convenient height from the ground. Suggestions along this line are given in Chapter 5.

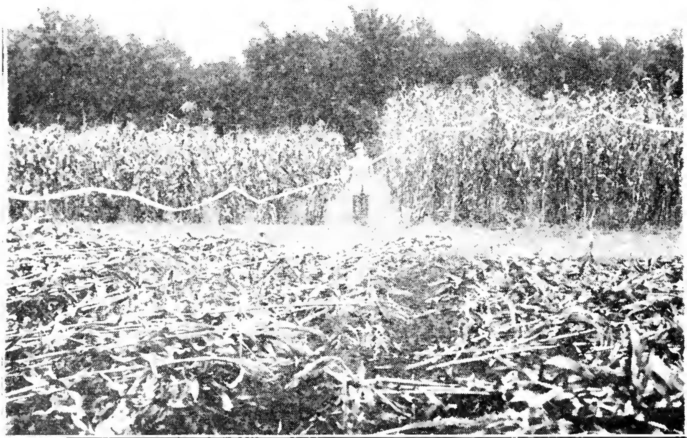
Every few years, however, it is a good plan on one side of the field to grow side by side with the home variety of corn another sort which has a well-founded reputation for high yielding power. If this supposedly high yielding corn from the outside does unusually well, it may be a good plan to start all over with it or to mix it with the home corn. No special methods are necessary in this kind of corn breeding. Practical farmers have followed this general plan for fifty years, and as yet there is no sure proof that a better method exists.

Four general methods of corn breeding have been practiced by corn breeders. These four methods are, (1) selection, (2) ear-row breeding, (3) cross breeding and (4) inbreeding.

Selection

Nearly all commercial varieties of corn have been formed by selection preceded oftentimes by a certain amount of cross breeding. The famous Illinois experiments started by Cyril G. Hopkins in 1896 and maintained for many years by Louis H. Smith, have demonstrated that unusual changes in type may be obtained by long-continued selection. After eight or ten years of selection for low ears at the Illinois station, they obtained a strain which on the average carried its ears less than two feet from the ground, whereas another strain developed from the same original Leaming, but selected for high ears, carried its ears more than seven feet from the ground. After twenty years, a strain of corn selected for high oil contained over ten per cent on the average, as contrasted with two per cent for the strain selected for low oil. In like manner, a high protein strain containing sixteen per cent protein was developed and a low protein strain containing six or seven per cent. In every case but one, however, these selections resulted in reduced yielding power. The one exception was the strain selected for two ears, which, at last reports from the Illinois station, was still yielding about as well as Reid corn. The other selections have yielded on the average only about three-fourths as well as Reid corn. It seems that selection for one particular thing results after a time in close breeding and that this reduces the vigor.

Most of our early corn breeders assumed that a moderately large ear with a deep kernel and a well-filled butt and tip was fundamental to yielding power. They selected for this one thing above everything else in developing our modern types of corn. In all probability, the pioneer corn breeders, by following this method, brought about a considerable increase in the yielding power of the corn which they had received from the Indians. It has been found, however, by repeated experiments during the past twenty years that in our modern Corn Belt varieties, no ear character is so very closely associated with yield. At



Low ear and high ear corn at Illinois station, developed by selection from same original Leaming.

the Ohio station, they selected for shallow grained corn year after year for a number of years, but the yield of shelled corn per acre was not impaired thereby. Seed from ears with bare tips seems to yield just as well as seed from ears with well-filled tips. By selection, it is possible to develop corn of beautiful appearance, but it seems to be very difficult to develop corn of outstanding yielding power. So far as we know now, very few of the stalk or ear characteristics which we can see with the eye are at all closely related to yield in our ordinary varieties of Corn Belt corn. Of course, it is obvious that in the case of a corn which is too late for the season that one of the things which must be done is to pick for a smaller ear and stalk, and vice versa. But in the case of a well acclimated strain, no method of selection has yet been found which has so very much effect on yielding power. It has been

found possible to alter the appearance of the ear and stalk considerably but the improvement of the yielding power by any method of selection has been found to be very difficult.

Ear-Row Breeding

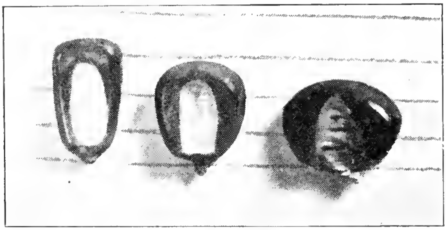
In the closing years of the nineteenth century and the opening years of the twentieth, the Illinois and Ohio stations developed the "ear-row" method of corn breeding. The theory of this method seemed so sound that every one had great hope that the inherent yielding power of corn subjected to this method of breeding would be greatly increased.

To begin with, fifty or a hundred good ears of a high yielding strain were picked out. These were planted an ear to a row, part of the seed from each ear being saved for planting the year following. Each row was weighed up separately in the fall, and it was invariably found that some of the good rows would yield about twice as much as the poor rows, and ten or twenty bushels per acre more than the average of the field. The plan was then to go back to the remnant seed of the fifteen or twenty ears which had produced these high yielding rows and plant them the following year in a small plot by themselves, an ear to the row. It was supposed that seed saved from this plot would yield much more than the original corn. As a matter of fact, the results were not so very encouraging. This was ascribed to inbreeding, and the method was modified to provide for detasseling of alternate rows and saving seed only from the detasseled plants. Much time and thought was spent on developing fine points in the method. In recent years, very little has been said about the ear-row method because no outstandingly high yielding strain of corn has been developed by it. Here and there, practical farmers have used the method for a short time, but they have almost always dropped it after a year or two. At the Nebraska station they found, after fourteen years of continuous ear-row breeding with Hogue Yellow Dent, that the yielding power had been decreased about one-third of a bushel per acre from the regular Hogue handled in the ordinary way. By crossing four of the high yielding strains isolated by the ear-row method, the yield was increased about one and one-half bushels per acre, as an average of seven years' tests. It would seem that scarcely one farmer in a thousand is justified in making any effort to improve his corn by the use of the ear-row method. Even in the hands of expert corn breeders the ear-row method of increasing corn yields has not proved so very satisfactory.

Cross Breeding

About 1910, a number of the experimental corn breeders became temporarily enthusiastic over the possibilities of improving yielding power by crossing two varieties. By planting two varieties in alternating rows and detasseling the one, it is easily possible to obtain cross-bred seed to plant the year following. At the Connecticut and Minnesota

stations, they have found that crosses between a high yielding flint variety and a high yielding dent will often yield more than either parent. At the Michigan experiment station, in the late seventies, and at the Illinois experiment station, in 1892, they found that the cross-bred seed yielded several bushels more per acre than the higher yielding of the two parents. More recent and complete experiments, however, at the Iowa and Nebraska stations, indicate that very few crosses will yield as well as Reid Yellow Dent in Iowa or Hogue in Nebraska. As a four-year average, the highest yielding cross-bred corn at the Nebraska station was a cross of Reid and Hogue which yielded 45 bushels per acre



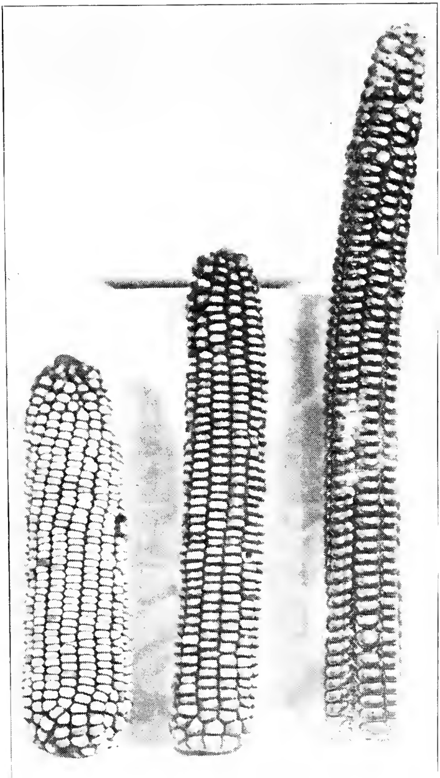
Crossing flint and dent. The kernel of the first generation hybrid is in the center.

as compared with 45.2 bushels for pure Hogue and 44.9 bushels for Reid. In one year the cross outyielded the Reid by nine bushels and the Hogue by four bushels, but in the other three years the pure parents had the advantage. Thirteen different crosses at the Nebraska station yielded as a four-year average, 1.6 bushels per acre less than the average of their parents. At the Iowa station, the results have been much the same, although it was found that a medium late flint from Argentina, crossed with Reid, oftentimes yielded more than the pure Reid. The bulk of the evidence indicates that crossing two dent varieties is not ordinarily worth while, but that the crossing of flints and dents may have some possibilities. It seems that the average Corn Belt farmer will not find it worth while to produce cross-bred seed himself, and, unless some new and startling combinations are found, it is very doubtful if it will pay him to buy cross-bred seed from anyone else.

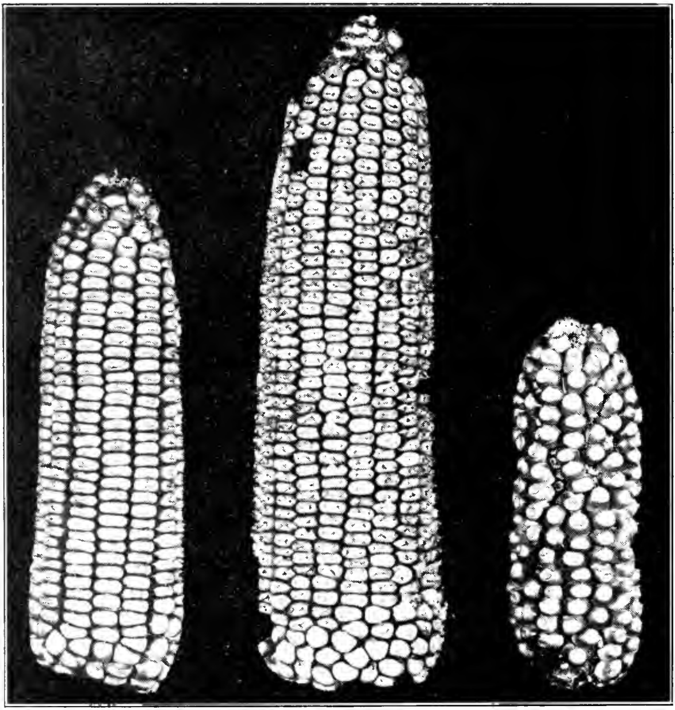
Inbreeding

The newest method of corn breeding is based on developing inbred strains of corn by putting the pollen of a plant on the silk of the same plant and continuing this "selfing" generation after generation until after four or more generations absolutely distinct inbred types have been produced. The inbreds as usually developed by this method yield about twenty bushels per acre under the same conditions that ordinary corn yields fifty bushels. When two unrelated inbreds are crossed, however,

startling results usually follow. At the Nebraska station, where all other methods of corn breeding have failed to produce a higher yield than Hogue Yellow Dent, as grown in the ordinary way, it was found, as a four-year average, that the cross of eight sets of two inbreds each yielded forty-eight bushels, as compared to forty-one bushels for the Hogue in the same years. Occasionally two inbreds do not "nick" well, and yield only half as much per acre as the variety from which they were derived. On examination, it will generally be found that inbreds producing such results are either closely related, or have some serious weakness in common, or are weaker than the average inbred. At the Connecticut station, where corn has been inbred for a greater number of generations than any place else in the world, it has been found that while crosses of two inbreds have often yielded more than the original variety, that even higher yields were obtained by crossing four inbreds together to produce a "double cross." This takes two years. For instance, if A, B, C and D are the inbreds, the method is to produce single crosses, AB and CD, the first year and then cross these the following year to produce double cross ABCD. This double crossed ABCD seed, when planted, has given exceptionally good results at the Connecticut station. The single crossed seeds produce plants and ears which are very uniform, every plant and ear looking almost exactly like every other plant and ear. The double crossed seeds, however, pro-



Crossing flint and dent. The first generation hybrid is in the center.



On the left an inbred, which was developed after five years of selfing. On the right inbred No. 1-6 of the Connecticut Station, which has been selfed for seventeen years. In the center the cross of the two, which is a vigorous, productive type, producing fully as much as Reid corn and twice as much as either inbred parent.

duce plants and ears which vary from one another about as much as is the case in the ordinary variety. This variability may account in some measure for the double crossed seed yielding more than the single crossed.

Practical Method for Farmers

What the final practical outcome will be of this new theory of producing inbred strains and then combining them into single, double or even quadruple crosses, no one can say. The method looks promising, but there are some drawbacks. The cross must be made every year. Seed selected from a high yielding single cross is very disappointing in its ability to yield the next generation. It promptly lapses back toward

its inbred form, and usually yields only about three-fourths as well as the year before. If this crossing of inbred strains is ever used in a practical way, it probably will be necessary for Corn Belt farmers to buy their seed every year from seedsmen or seed associations which are specializing on this kind of thing. However, it may be that further experimenting will demonstrate that it will be possible after forty or fifty good inbreds have been located which are mutually compatible to combine them together in the form of a new variety, with the result that the yielding power of this complex cross will not slide downhill in later years in the same way as a single cross or a double cross. Just what the application of breeding and cross breeding inbred strains will be, no one can say with any certainty. It does seem to be plain, however, that this method offers the best hope of making any genuine progress in corn breeding. Nevertheless, it is probable that not until after 1930 will this new idea in corn breeding have gone far enough to mean anything one way or another to the practical corn farmer. For the time being, the practical thing for him to do is to save sound seed of a standard high yielding strain in the manner suggested in Chapter 5. From time to time, the more experimentally minded can try out corn which has done well in corn yield contests and also single and double crosses of inbreds which may be offered by experiment stations and seed companies as time goes on.

CHAPTER 33

TECHNIQUE OF INBREEDING

INBREEDING involves placing live pollen of a plant on the silks of the same plant and also keeping out any foreign pollen. The customary way of doing this is to tie a twelve-pound pinch bottom paper sack over the tassel just before it begins to shed pollen. A three-pound paper sack or a glacine bag (two and a half by five inches is a convenient size) is slipped over the ear shoot as soon as it is out far enough so as to hold the bag on and before any silks have appeared. Thump the tassel bag

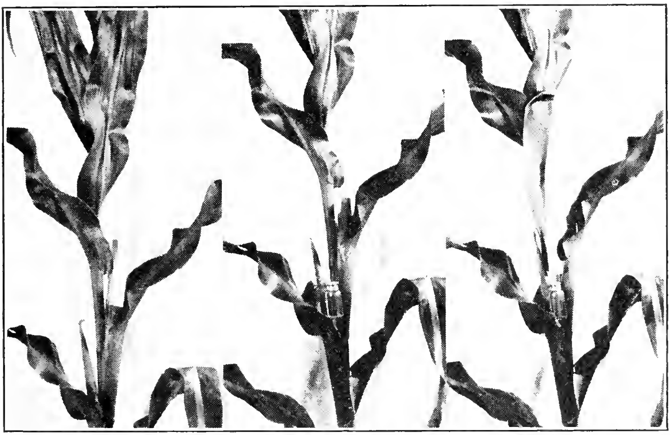
Old-fashioned method of inbreeding. Shaking pollen into sack.

to tell when the pollen has started to shed. If the silks are out and pollen is shedding, take the tassel sack off and invert it over the ear shoot and tie it, allowing the bag to bend in the middle while tying so as to avoid losing the pollen. After the tying is completed, straighten out the bag and shake it suddenly, so that a considerable amount of the pol-

len in the bag will fall on the silks enclosed in the bag. In a week or two, especially if there has been a rain, the ear shoot will have grown so much that it will be necessary to loosen the string holding the bag on.

New Method

In 1922, a new technique of inbreeding was devised by Merle T. Jenkins, of the United States Department of Agriculture. It is known as the bottle method, and has several advantages for people who are inbreeding more than 100 plants a year. With the bottle method, the ear shoots are covered up in just the same way as with the old-fashioned method, but the tassels are not covered at all. When the silks are out and the tassel has begun to shed, the tassel is pulled out and put in a twelve-pound pinch-bottom paper sack and the base of the tassel is placed in a one or two-ounce bottle filled with water and tied to the corn stalk at the same place as the ear shoot comes out. The paper sack encloses both the ear shoot and tassel and is held in place by a paper clip or a



Illustrating Jenkins' bottle method of inbreeding corn. On left, glacine bag placed over ear-shoot before silk appears. In middle, bag removed, silk and tip of ear-shoot cut off and bottle attached. On right, twelve-pound paper sack with tassel and ear-shoot inside of it. Tassel is kept alive and shedding pollen for a day or two by water in the bottle. In the meantime, the silks have come out again. (Courtesy of United States Department of Agriculture.)

string. The silks of the tassel are cut back together with the tips of the husks for an inch, or even two inches, just before the twelve-pound sack with its enclosed tassel is put over it. A day or two later, the silks grow out again and the water in the little bottle has kept the tassel alive so that it is still ready to furnish pollen when the silks are ready

again. The bottle is most quickly tied to the stalk by means of 22-gauge copper wire, such as can be bought from a radio supply house. Several hundred bottles can be prepared in advance by twisting a foot of the copper wire around the neck of each in such a way that there will be two ends about four inches long to twist around the stalk. The bottles are carried to the field in a water bucket. The bottle method appears more difficult and complicated than the old-fashioned way, but in actual practice is much more rapid. Two men can inbreed forty to sixty plants an hour. One very great additional advantage is that rain often drove water into the tassel bags used in the old-fashioned method, making it necessary to do a lot of work in replacing them, and sometimes making it impossible to inbreed certain plants at all.

Growth of Tassels and Silks

Following are some facts about the flowering habits of our typical Corn Belt stalk of corn, which may be worth while to anyone who is expecting to do some inbreeding:

1. From the time the tassel first appears until the first pollen is shed is usually about a week.

2. Silks usually appear two or three days after pollen shedding first begins, although there are occasional plants whose silks come out a day or two in advance of the pollen.

3. Pollen shedding continues for about a week, although a few plants produce tassels which will continue to shed for ten or twelve days.

4. With a moist atmosphere and a rather low temperature, corn pollen may live two or three days, but with temperature and humidity as it usually is in the ordinary corn field, nearly all of the pollen dies within twenty-four hours after it leaves the tassel.

5. Silks are receptive to pollen for two weeks or even longer after they first appear. If they are not fertilized, they may grow to a length of ten or twelve inches, although in the case of some plants the unfertilized silks make very little more growth than the fertilized. After a pollen grain falls on a silk, it grows with great rapidity, germinating and sending a pollen tube through seven or eight inches of silk to the ovule (unfertilized corn kernel) within twenty-four hours.

6. If a tassel is pulled before it begins to shed pollen, it will rarely live to shed, even though it is placed in water. However, after a tassel has begun to shed it may be pulled and continue to produce viable pollen for a day, even though it is not placed in water.

7. There is considerable difference in the habits of different corn plants, but the typical plant acts about as described in the foregoing.

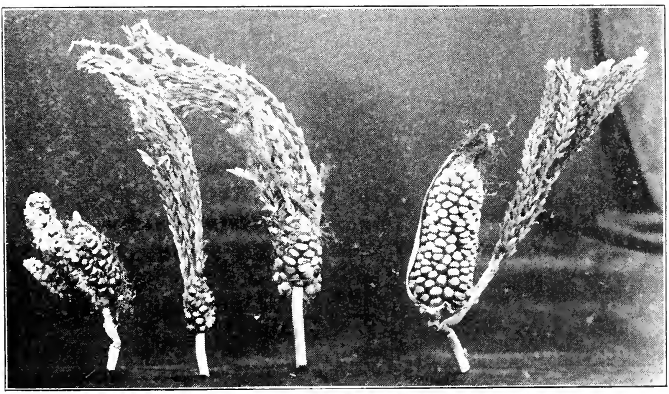
CHAPTER 34

HEREDITY IN CORN

SCIENTISTS have probably done more fundamental work with the heredity of corn than with any other plant or animal, with the exception of the Drosophila (fruit fly). Practically none of this scientific work has yet been of practical value, although inbreeding and the crossing of inbred strains (described in Chapter 32) promises eventually to be of very real importance.

Mendelian Characters

Most of the corn heredity work has centered around the problem of finding which characters are Mendelian dominants and which Mendelian recessives. More than one hundred Mendelian characters have already



Floral abnormalities. Branched ear and ears bearing tassels. Most freaks of this sort are Mendelian recessives, which are found to some extent in every commercial corn field, but which do not often get a chance to express themselves.

been discovered, and by 1935 several hundred more will undoubtedly be worked out. Many of these characters are freaks which so affect the plant that it does not have the capacity of producing an ear which a farmer would save for seed. In spite of this, they are found to some extent in nearly all corn fields. They seem especially likely to be found in rather large numbers on those farms where a special effort has been made to breed a high yielding strain of corn by the ear-row method.

One of the commonest of freaks is a white stripe running through the leaves. A plant of this sort when inbred and the seed planted produces plants all of which are affected with striped leaves. But if the silks of a striped-leaved plant are fertilized with pollen from a normal plant, and the seeds produced are planted, the result will usually be plants all of which are normal. Occasionally, a plant which appears normal carries the striped character in one-half of its pollen grains, and when the pollen of such a normal plant is used on the silks of the striped plant the result will be plants one-half of which carry striped leaves and one-half of which are normal. Normal plants which are produced in this way bear pollen one-half of which carries the striped-leaf factor and one-half of which are normal. Also, one-half the ovules or unfertilized corn kernels carry the striped leaf factor and will produce a striped leaf plant if striped-leaf pollen falls on their silks. The striped-leaf character is known as a Mendelian recessive and normal leaf color is the Mendelian dominant.

Following are some of the Mendelian recessives, affecting the plant or leaf:

1. Blotched or mottled leaf.
2. Pale green leaf color.
3. Yellow leaf color.
4. Pure white seedlings.
5. Crinkly leaf.
6. Short jointed or the brachytic type of dwarf corn.
7. Crooked jointed or zig-zag corn.
8. Tassels with no pollen.
9. Leaves with a mid-rib but no real leaf.

Nearly all abnormalities, and there are probably hundreds of them, are Mendelian recessives. Some of the outstanding exceptions in the way of unusual characters which are Mendelian dominants are:

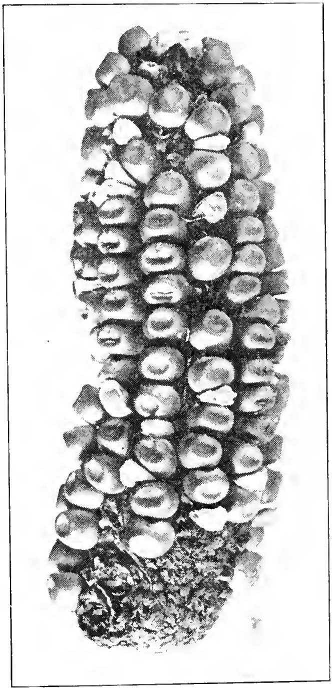
1. Purple plant color (governed by three dominant factors, A, B, Pl).
2. Brown plant color (determined by dominant B and dominant Pl with recessive a).
3. Pod corn or primitive corn with a husk covering each kernel.
4. Red kernels which owe their color to the red pericarp or hull.

Xenia

In the case of factors affecting the kernel, it is very easy to get confused as to the nature of corn heredity because of what is known as xenia. When a pollen grain from an ordinary yellow dent corn fertilizes the ovule of white corn, one of the pollen nuclei joins with the germ of the ovule and the other nucleus joins with the two polar nuclei of the ovule, which union later results in the endosperm or starchy part of the kernel. Yellow colored endosperm is a Mendelian dominant and because of this xenia or double fertilization, the effect of yellow pollen when used to fertilize white corn may be seen the same year, although the color is paler than that of pure yellow corn. The hull or pericarp is not affected by xenia. That is the reason why pollen from red corn

has no immediate effect, although a year later it shows up strongly. The pericarp, botanically, is a part of the mother plant, whereas the endosperm is a product of the recent mating.

Blue color in corn kernels is found in the aleurone layer, which is a very thin layer found just between the pericarp and the endosperm. The aleurone color is subject to xenia. Blueness in the aleurone is dependent on four different Mendelian dominants (A, C, R and Pr), all of which must be present. Moreover, another factor (I) must be absent. All of our common dent varieties have one or two of these dominant characters which make for blue color in corn. Very few of them, however, have what is known as the R factor. The other three factors (A, C and Pr) are more commonly found in ordinary corn. This study of blue color in corn kernels is an exceedingly complex matter, and because it is so difficult and has no immediate practical application, it will not be gone into in further detail, but the student will be referred to Memoir 16 of Cornell University.



Illustrating defective kernels. A Mendelian recessive. (Courtesy of Connecticut Experiment Station.)

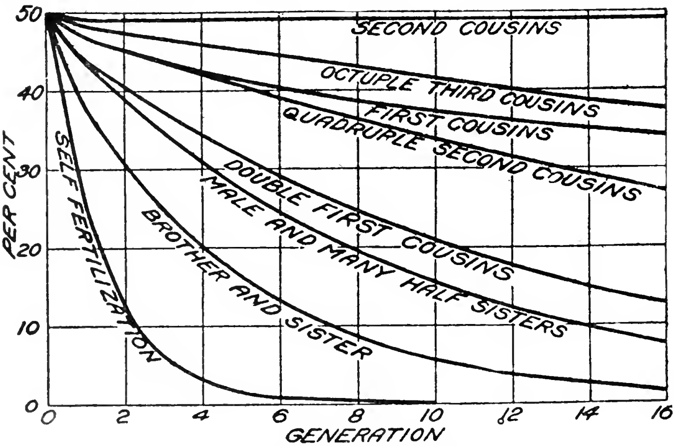
Heterozygosis and How Inbreeding Affects It

A plant or animal is said to be homozygous when all of its germ cells carry the same hereditary properties. Most corn plants are not homozygous, but are heterozygous (germ cells differ from one another). However, there are varying degrees of heterozygosity. For illustration, we may say that a completely homozygous corn plant produces germ cells each of which carries the inheritance ABCDEFGHIJ. A slightly heterozygous corn plant might carry half its germ cells with aBCDEFGHIJ and the other half with ABCDEFGHIJ. Actually, the ordinary corn plant carries dozens of different types of germ cells, as may be roughly illustrated in part as follows: ABCDEfghij; ABcdeFGhij; ABcdEfgHij; ABCdefghij; ABcDeFgHiJ, etc., etc. Perhaps this particular plant may be homozygous for A and B and het-

erozygous for all else. In the ordinary corn field, it may be roughly assumed that the average plant is homozygous for about half of its characters and heterozygous for half. As long as wind pollination continues, and the farmer does not line-breed by planting closely related ears, there will be little or no change in the proportion of homozygosity and heterozygosity. If, however, a plant which is 50 per cent heterozygous is selfed, the next generation will bear germ cells which are much alike, and the probabilities favor only 25 per cent heterozygosity. In succeeding generations, the heterozygosity should decline to the following percentages: Second, 12.5 per cent; third, 6.25 per cent; fourth, 3.12 per cent; fifth, 1.56 per cent, etc. After five generations of selfing, it is a general rule that almost complete homozygosity is reached, provided the plant to start with was 50 per cent homozygous. It takes about seventeen generations of brother and sister mating to give the same degree of homozygosity as five generations of selfing.

Why Heterozygosis Increases Vigor

It is theoretically possible some day to find an inbred strain which is homozygous only for good qualities and which would therefore be



Illustrating how a blood strain which is 50 per cent heterozygous is affected by different numbers of generations of different methods of breeding. Six generations of selfing should bring 99.2 per cent homozygosity if the strain was 50 per cent homozygous to start with. (Bulletin 1121, United States Department of Agriculture.)

vigorous. Actually, all inbred strains so far developed by selfing for four or more years are decidedly unproductive. When two different homozygous inbreds are crossed, the result is usually great vigor, as described in Chapter 32. This kind of vigor is supposed to be due to

the fact that most good characters are Mendelian dominants and most bad ones are Mendelian recessives, and that the first generation cross of two strains gives a chance for all of the good characters of both parents to appear. with none of the bad, unless the bad are found in both parents. It is this theoretically sound background which has caused so many experimenters to spend so much time with corn inbreeding work in recent years.

Linkage

The most recent step forward in corn heredity has been in the study of linkage, discovering which Mendelian factors are located in the same chromosome. Corn has ten chromosomes and it is probable that by 1935 nearly 100 different factors will have been placed. Not only this, but it will be possible to say about where in each chromosome each of the factors is located. This kind of work belongs to the professional geneticist at the present time. Eventually, it will have very practical applications because after the freakish factors are definitely located in their various chromosomes it may be possible to locate the position of some of the factors which make for yield. In the meantime, it is worth while to know that this kind of work is going on and to be prepared to learn more about it when it finally begins to have some practical applications.

Alphabetical List of Genetic Factors in Corn

List furnished by Dr. Emerson, of Cornell University. Factors capitalized, dominant; not capitalized, recessive.

A—anthocyanin. General plant color including aleurone, pericarp, stem, leaves, etc.
ad—adherent. Leaves and tassel adhering.
an—anther ear. Semi-dwarf plant with anthers throughout ear.
ar—argentia. Silvery leaf.
B—"brown." A plant color factor. An allelomorphic series B, B^w, b.
bc—brachytic. Dwarf plant.
bh—blotched aleurone.
bl—blotched leaf.
[a]br—brown aleurone.
bv—brevis. Dwarf plant.
C—colored aleurone.
co—coherent. Branches of tassel cohering.
cr—crinkly leaf.
d—dwarf plant with anthers throughout ear.
de—defective. Little or no development of endosperm and embryo.
[a]dt—dotted leaf.
f—fine striped leaf.

[a]Mode of inheritance not definitely established.

fi—fine streaked leaf.
fl—floury-flinty endosperm.
[a]Fs—fasciated ear.
g—golden leaf.
gl—glossy leaf.
gs—green striped leaf.
I—inhibitor of aleurone color.
in—intensifier of red and purple aleurone.
[a]Ir—interrupted ear.
j—japonica striped leaf.
l—luteus (yellow) seedling.
lg—liguleless leaf.
li—lineate leaf.
M—mottled aleurone—with heterozygous R.
mr—midrib. Leaf consists of but little more than the midrib.
ms—male sterile. Anthers produce no pollen.
na—nana. Dwarf plant.
nk—naked. Cob and tassel almost free from spikelets.
P—pericarp and cob color. An allelomorphic series P^{rr}, P^{ww}, P^{wr}, etc.
pb—piebald, yellow and green spotted seedling.
pg—pale green seedlings.
Pl—purple plant color.
Pr—purple aleurone.
R—red aleurone. An allelomorphic series, also affecting plant colors and pericarp: R^r, R^g, r^r, r^g, r^{ch}, etc.
ra—ramosa ear.
[a]ru—rugose leaf.
sh—shrunken endosperm.
[a]sk—silkless. No silks on cob.
sl—slashed. Slashed or shredded seedling.
sm—salmon silks.
sp—spear. Spear-like seedling. Usually lethal.
st—stippled aleurone.
su—sugary endosperm.
te—tassel ear } Two types producing only pistillate flowers in
ts—tassel seed } the tassel.
Tu—tunicate ear (pod corn).
[a]tw—twisted stalk.
v—virescent seedling.
w—white seedling.
ws—white sheath.
wx—waxy endosperm.
Y—yellow endosperm.

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[a]Mode of inheritance not definitely established.

Yp—pale yellow endosperm.
ys—yellow striped leaf.
zb—zebra—transversely striped leaves.
zg—zigzag stalk.
zu—Zuni aleurone (colored caps).

(This list was quite complete in 1922, but new factors are being added by corn geneticists every year.)

Chlorophyll Factors

Seedlings—
pb—piebald.
pg—pale green.
v—virescent. (Lindstrom, 1918.)
w—white. (Lindstrom, 1918.)

Seedlings and mature plants—
ar—argentia.
f—fine stripe.
l—yellow seedlings with w or v. Yellow striped in mature japonica. (Lindstrom, 1918; 1921.)
zb—zebra.

Mature plants—
bl—blotched leaf.
dt—dotted leaf.
fi—fine streaked.
g—golden. (Lindstrom, 1918.)
gs—green striped. (Lindstrom, 1918.)
j—japonica striped. (Lindstrom, 1918.)
li—lineate leaf. (Collins, 1920.)
ws—white sheath.
ys—yellow striped.

Plant and Anther Colors

(Emerson, 1921)

	Plant—	Anthers—
Ia—A B Pl R^r	—purple	purple
Ib—A B^w Pl R^r	—weak purple	purple
Ig—A B Pl R^g	—purple	green
IIa—A B pl R^r	—sun red	pink
IIb—A B^w pl R^r	—weak sun red	pink
IIg—A B pl R^g	—sun red	green
IIIa—A b Pl R^r	—dilute purple	purple
IIIg—A b Pl R^g	—green	green
IVa—A b pl R^g	—dilute sun red	pink
IVg—A b pl R^g	—green	green
V—a B pl	—brown	green
VIa—a B pl	—green (or slight brown in sheaths)	green

VIb—{ a b Pl —green (or slight brown in tassel)........green
a b Pl r^{ch}—green (considerable brown in tassel)........green }

VIc—a b pl —green.

Factor r^r has the same effect on plant color as R^r, and r^g the same effect as R^g.

Silk Colors

(Anderson, 1921a)

A Sm P—green.
A Sm p—green.
A sm P—salmon.
A sm p—brown.

Colors indicated are of silks under husks. Parts exposed to sunlight may be red if R^r or r^r is also present. P is the factor for red pericarp. With aa all silks are green.

Pericarp Colors and Patterns

(Anderson, 1921b)

Cherry pericarp series—	Pericarp color—	Cob color—
A Pl r^{ch}	cherry	purple
a Pl r^{ch}	brownish	brownish
A pl r^{ch}	white	white
a pl r^{ch}	white	white
Red pericarp series—		
A P^{rr}	red	red
A P^{or}	orange	red
A P^{wr}	white	red
A P^{ow}	orange	white
A P^{cw}	white-capped red	white
A P^{vv}	variegated	variegated
A p	white	white

With aa brown color in place of red.

Aleurone Colors and Patterns

(East, 1912; Emerson, 1918)

i A C R Pr—purple.
i A C R pr—red.

i A C r
i A c R
i a C R
i A c r
i a C r
i a c r } white.

I A C R Pr—white.

Bh—blotched. Shows only in A c R Bh.
br—brown. Relation unknown.

in—intensifier.
M—mottled. Shows only in r r R.
st—stippled.
zu—Zuni.

Endosperm Colors

Y—yellow. (East & Hayes, 1911.)
Yp—pale yellow. (Emerson, 1911.)

Endosperm Texture

Su Wx—starchy. (Collins & Kempton, 1914; Kempton, 1919.)
Su wx—waxy. (Collins & Kempton, 1914; Kempton, 1919.)
su Wx—sugary. (Collins & Kempton, 1914; Kempton, 1919.)
su wx—sugary. (Collins & Kempton, 1914; Kempton, 1919.)
Fl Fl Fl—flinty. (Hayes & East, 1915.)
Fl Fl fl—flinty. (Hayes & East, 1915.)
Fl fl fl—floury. (Hayes & East, 1915.)
fl fl fl—floury. (Hayes & East, 1915.)
de—defective seeds. (Jones, 1920.)
sh—shrunken endosperm. (Hutchinson, 1921.)

Plant Height

Dwarfs and semi-dwarfs—
an—anther ear (variable in height). (Emerson & Emerson, 1921.)
bc—brachytic. (Kempton, 1920.)
bv—brevis.
cr—crinkly.
d—dwarf. (Emerson, 1912b; Emerson & Emerson, 1921.)
na—nana.
te—tassel ear. (Emerson, 1920.)
ts—tassel seed. (Emerson, 1920.)
tw—twisted.
zg—zigzag. (Eyster, W. H., 1921a.)

Leaf Characters

cr—crinkly.
gl—glossy.
lg—liguleless. (Emerson, 1912a.)
mr—midrib.
ru—rugose.
sl—slashed.
sp—spear.

Ear Characters

d—dwarf. With anthers in the ear.
an—semi-dwarf. With anthers in the ear.
ra—ramosa. Branched ear. (Gernert, 1912.)
Fs—fasciated ear. (East & Hayes, 1911; Emerson, 1912b.)

in—interrupted ear. (Emerson, 1912b.)
nk—naked. (East & Hayes, 1912.)
sk—silkless.
Tu—tunicate. (Collins, 1917.)
te—tassel ear. Zigzag rows in ear due to development of both flowers of the spikelet.
ts—tassel seed. Zigzag rows in ear due to development of both flowers of the spikelet.

Tassel Characters

ad—adherent.
co—coherent.
ms—male sterile. (Eyster, L. A., 1921.)
nk—naked.
ra—ramosa.
Tu—tunicate.
te—tassel ear.
ts—tassel seed.

Linkage Groups in Corn

List furnished by Dr. Lindstrom, of the Iowa Experiment Station.

I, the C group, including also I, sh, wx, v_1
II, the R group, including also l, S, g, li_1, pg_1, (w_2?)
III, the Su group, including also Tu
IV, the B group, including also lg, ts_1, v_4
V, the Y group, including also Pl, sm, fi, bh, w_1, w_5, w_6
VI, the P group, including also br, ts_2, f
VII, the A group, including also v?

Miscellaneous Linkages

Yp—pg_3
d—pg_2
gs—z_1–an
gl—fr–v

(This was the situation as viewed by Dr. Lindstrom early in 1923. Many more factors will doubtless be placed in their linkage groups every year as more experimental work is done by the corn geneticists.)

CHAPTER 35

CORN JUDGING

CORN shows first became really popular about 1890, reaching their crest about 1910. In the early corn shows, the idea was to give the prize to the sample which gave indications of the greatest yielding power. The men who drew up the early score cards assumed that of course high yield was associated with ears as large as the ordinary season would mature, and ears with a high percentage of shelled corn. Therefore, in the central part of the Corn Belt their ideal was an ear ten inches long, seven and one-half inches in circumference, with eighteen to twenty-two rows packed together tightly on the cob and carried out over the tip and well-rounded butt. They wanted the space between the rows of kernels, both at the cob and on the outside of the ear, to be as narrow as possible because that meant a higher percentage of shelled corn. Deep kernels, keystone in shape, and moderately wide, met their ideals better than either the narrow shoe-peg kernel or the shallow, extremely square kernel, both of which are usually associated with a lower shelling percentage. They preferred ears with straight rows and cylindrical in shape, because the kernels were more uniform and could be planted with fewer skips by the corn planter. Large germs were desired because that meant more oil and protein in the kernel and therefore more feeding value. For probably fifty years before the popular corn shows of the early twentieth century, these common sense points had appealed to thoughtful corn farmers everywhere, and the men who made out the score cards in the nineties merely reflected the opinions of the men who had thought most about corn.

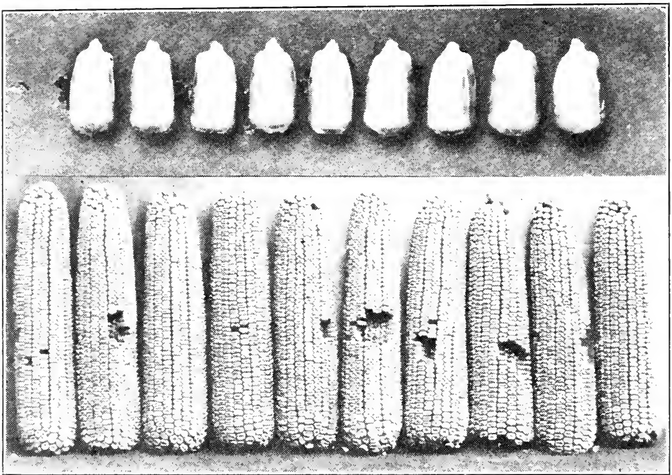
Fancy Points

About 1900, the corn judges began to prefer corn with a rough dent. The rough dented corn seemed to have straighter rows and more uniform kernels, which also seemed to be a little deeper. It was also advisable to develop fancy points of this sort in order to enable the judges to make any distinction between the hundreds of competing samples, most of which were almost equally good from the standpoint of the original score card. And so it came about that corn judges unconsciously came to think more and more about fancy points.

Tests Upset Ideals

The first corn shows were held before the days of careful experimental work. It is not surprising, therefore, to find that actual yield tests with different types of corn rudely upset some of the most cher-

ished ideals of the early corn judges. For ten years the Ohio station continuously selected for moderately long ears of corn and for moderately short, and contrasted the yielding power of the two strains. The short ears, only six or seven inches in length, seemed to have the ability to yield almost exactly the same as the ears nine or ten inches long. Bare



This type of ten-ear sample, which represents hundreds of hours of labor picking over thousands of ears of corn, wins at the corn shows. No one can tell in advance whether such corn will yield as much or more than ordinary corn.

tipped ears with nearly an inch of cob showing yielded about the same amount of shelled corn per acre as ears with perfectly filled tips. Ears shelling out only 76 per cent yielded considerably more ear corn per acre and fully as much shelled corn as ears shelling 88 per cent. Smooth corn slightly outyielded the rough corn. Carefully conducted tests of this sort at the Ohio, Nebraska and a number of other stations made it appear extremely doubtful if many of the points on the old-fashioned corn score card were worth while from the standpoint of yield.

No one has as yet learned enough about corn to know just what relationship there is between yield and the different ear and kernel characteristics. The relationship seems to be different in different seasons and on different soils. The following yield score card is based chiefly on experimental work at the Iowa station and probably applies as well as any to central Iowa and Illinois.

Yield Score Card
(No fancy points)

	Points
Solid, well-matured ear which weighs like lead (heavy for its size, with kernels firm on cob)	15
Length of ear(at least 7 inches)	5
Circumference of ear (at least 5.5 inches)	5
Width of kernel (not less than one-fourth inch wide)	15
Thickness of kernel (not more than 8 kernels to the inch)	10
Depth of kernel (at least seven-sixteenths inch deep)	15
Kernel plump at tip	15
Kernels without blistering or damage by mice	5
Kernels with bright, large germ (germ should be clear and waxy when cut)	5
Kernels come loose from cob without leaving tip cap or taking part of cob with them	5
Kernels hard, horny and shiny, without showing white starch on their backs	5
Total	100

It is assumed in this score card, as should be the case with all corn score cards, that ears which will not grow are given no consideration whatever. In Illinois and parts of Iowa where root rot diseases are serious, the last point—hard, horny, shiny kernels free from starch—probably should be given 15 or 20 points instead of only five, for it has been definitely proved that starchy kernels are more susceptible to these diseases and yield less as a consequence. In Nebraska, especially in the western part, 15 or 20 points should be given to a smooth dent combined with a slender ear and freedom from starchiness. On the other hand, the rich bottom lands of central and southern Indiana seem to yield more when planted to a rough, somewhat starchy corn carrying twenty or even twenty-two rows of kernels, than when planted to the smaller, slender-eared type with its horny, shiny kernels.

What Corn Judges Like

While no one knows much about measuring the effect of ear and kernel characteristics on yield, it is fairly easy to learn what type of corn will appeal to corn judges at the big corn shows. In the single ear classes in the central part of the Corn Belt, the ideal ear is ten inches long, seven and one-half inches in circumference, with twenty or twenty-two straight rows of kernels carried out to the tip (tip kernels being of the same type as the kernels on the body of the ear), and with a well rounded butt with only a small opening left for the shank. Of course, the ear must be straight and cylindrical in shape, with the diameter carried uniformly from the butt to within two or three inches of the tip, where a slight taper is permissible. The kernels must be moderately wide, keystone in shape, deep, plump at the tip, and without any trace of being shrunken or blistered. In Iowa and Illinois, the judges lay great emphasis on the backs of the kernels being horny and shiny, but in Indiana and at the International Grain and Hay Show they are not so particular about this point. In central Iowa, Indiana and at the

International the custom has been to favor the rough corn, whereas in Illinois, since 1920, they have been favoring the smooth corn with an exceedingly horny kernel, showing the least possible susceptibility to root rot infections. By attending corn shows and associating with corn judges, it is possible to learn their ideals and pick corn to meet them. In the ten-ear, thirty-ear and bushel classes, it is necessary to pay great attention to uniformity. All of the ears should be within an inch of the same length. None of the ears should carry less than eighteen rows nor more than twenty-two. The kernels should all be of the same size, shape and color, showing no trace of mixture with white pollen (if the variety is yellow) or yellow pollen (if the variety is white). In addition, the ears must be true to what the judges recognize as the variety type. To fulfill all of these requirements means that a man must start with seed from a recognized show strain and grow it out on rich soil and then go over 50,000 or 100,000 ears in the hope of finding a prize winning sample. Picking corn for show is interesting work which appeals to farmers with an eye for the beautiful. The premiums offered at the corn shows have made corn exhibiting profitable for many men. This has been especially true in central Indiana and the southern half of Iowa, where a combination of rich soil, a rather long season, and favorable rainfall have made it possible to grow beautiful, rough, large-eared corn very easily.

Shows Are in a State of Change

It seems that corn shows are now in a state of change, and that in the future the judges may pay somewhat more attention to the practical points and somewhat less to the merely beautiful. The weak point in all corn judging is that most of the really important functions of the corn plant which have to do with yield express themselves in other ways than through the shape of ear and type of kernel.

Corn shows and corn judges have an important place in drawing men of like tastes together, but the day is past when they are having much direct influence in improving the yield of our corn. The Iowa Corn Growers' Association has to some extent recognized this by inaugurating a scientific yield contest, as described in Chapter 36.

CHAPTER 36

CORN YIELD CONTESTS

PRACTICAL farmers long ago discovered that the corn which won at the corn shows was not necessarily high yielding corn. It was therefore suggested that farmers compete to see who could produce, not the best looking corn, but the most corn per acre. Such contests demonstrated that it was possible in the South, by means of extremely heavy fertilizing combined with a favorable season to produce over 200 bushels per acre. On rich clover sod land in the North it was found that occasionally, when all conditions were favorable, that over 130 bushels per acre could be produced. But the practical farmer again rebelled. He said that he had no time to fool around with a pet acre of corn which would not win a prize unless it happened to be favored with lucky rains at just the right time in July and August. As a result, acre yield contests are now used for the most part as a device to interest farm club boys. In this way, these tests have done an immense amount of good, definitely starting many boys on the path of becoming genuinely interested in all that makes for good farming.

Best Type of Test

The best type of corn yield contest involves growing several strains of corn side by side on the same land, to see which sorts will yield the most when all conditions are alike. This type of contest should be conducted for at least three years, and preferably for five. Since practical farmers are not in position to do the careful experimental work involved in this kind of a contest, it has been the custom for the county agent, the experiment station, or the Corn Growers' Association to supervise the planting and weighing. All the farmer who enters this kind of a contest has to do is to furnish a few pounds of seed (in some cases he also pays an entry fee of a few dollars to defray part of the expenses). The farmer has none of the bother of growing or harvesting, but at the finish receives the benefit of knowing how his seed compared in yielding power with other strains of corn grown under exactly the same soil and moisture conditions. If his corn has done well, he may develop quite a seed business. If it has done poorly, he will find it advisable to buy corn from someone whose corn has done well, growing the two sorts side by side on his own farm at first in order to verify under his own conditions the results of the yield test.

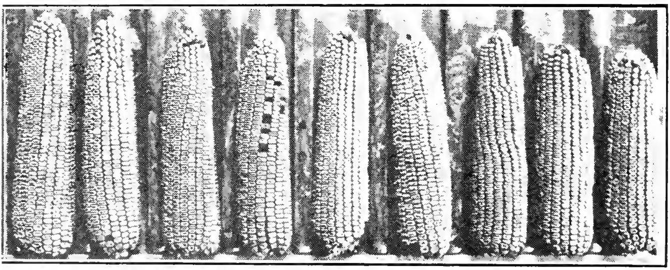
Woodford County Test

The first carefully conducted three-year corn yield contest of this sort was the Woodford county, Illinois, test, which was begun in 1919 and completed in 1921. Seed from 120 Woodford county farmers was

entered in this test in each of three years. These 120 sorts were grown side by side in two different places in the county. Every other row across the test field was a check sort not entered in the contest. By correcting the yield by means of the adjoining check, it was possible to take into account soil variations. The Krug strain of Reid Yellow Dent, which stood at the top as an average of the three years, outyielded the average corn in the contest by 6.6 bushels per acre, and the poorest, which was also a strain of Reid, by 17.1 bushels. The ten high yielders were grown again side by side in a number of different places in Woodford county, in 1922, and again the Krug corn outyielded the others. The Krug corn was also entered in the Iowa corn yield contest in 1922, and yielded within one bushel per acre as much as the corn which won first.

Iowa Yield Test

The Iowa corn yield contest was begun in 1920 by the Iowa Corn Growers' Association. The Iowa experiment station assists in planting and harvesting the plots of the strains, which are grown side by side under the same conditions. Each strain which is entered is grown in



Black Yellow Dent corn, which has yielded well as a three-year average in the Iowa Corn Yield Contest.

the eastern part of the state, the central, and the western, and at each place at least five plots of each strain are grown, thus making fifteen replications in all. Such a careful test involves an expense of about $20 for each strain of corn entered, and each farmer who sends in his seed to be tested is therefore charged $10, the other $10 being borne by the Corn Growers' Association. For purposes of the contest, the state is divided into four sections, northern, north-central, south-central and southern. Most of the strains entered in the northern section have been Silver King, whereas, in the southern and south-central sections the contest has chiefly been between different strains of Reid Yellow Dent. In the south-central section, where the competition has been the keenest, the Black strain of Reid has stood high as an average of three years, with a yield of seven bushels per acre more than the strain of Reid which was the lowest as an average of the three years. There were

many other strains of Reid which were lower yielding than this low strain, but the farmers growing them became tired of paying $10 to enter them after one or two years. In this respect, the Iowa form of corn yield contest is inferior to the Woodford county, Illinois, test, where all the farmers stay in every year and the results are not announced until the last year.

Technique of a Yield Test

In the ordinary county corn yield contest, the county agent sees that some ten or twenty different local strains are planted side by side on the same farm. Such a test awakens a lot of local interest, but unless the county agent neglects his other duties it is very difficult for him to make a really thorough comparison and as a result the ordinary county corn yield contest is rather inaccurate. The technique of conducting a corn yield contest in order to get the most accurate comparison of yielding power at the least expense of money and time has not yet been thoroughly worked out. In the Iowa corn yield contest the original plan was to plant the different sorts side by side in plots of four twenty-five-hill rows each, there being five replications of such plots for each sort. Only the two center rows were harvested, the theory being that the two outside rows might be affected by the sorts grown on either side. In actual practice, it was found that all of the sorts entered were so similar in their habit of growth that there was no need of having two border rows to eliminate plot competition. Under such conditions, it seemed possible to gain accuracy by having twenty replications of one row each rather than five replications of four rows each. In the Iowa contest, they have always grown a check sort every fifth plot in order to have a standard by which to correct for soil conditions. It seems, however, that the use of a check sort to correct for soil conditions is only doubtfully worth while when there are ten or more replications. The ideal way seems to be to have a row of check corn grown in every other row across the field or else to leave out the check and try to obtain accuracy by having at least ten replications. Refined mathematical and experimental methods are being applied to this problem, and it is expected that by 1928 the most practical way of determining the comparative yielding powers of different kinds of corn when grown under the same conditions, will have been discovered. In any event, it will always be necessary to run such a test for at least three years.

The benefit of such contests as the Iowa corn yield contest is that certain standard strains are discovered which have demonstrated their ability to yield well over a period of years. Farmers who do not enter such contests can get seed of such sorts to grow side by side with their home corn. Hundreds of farmers have done this as a result of the Iowa corn yield contest. Some of them have found that their home corn has a higher yielding power under their own conditions, but others have found that the high yielding corn discovered by the yield contest is fully five or ten bushels per acre better than their home corn.

CHAPTER 37

COMMERCIAL PRODUCTS OF CORN

ABOUT two hundred and eighty million bushels, or 10 per cent of the corn crop of the United States, is manufactured annually. Roughly, one hundred and eighty million bushels, or 6.5 per cent, are ground in the corn meal mills, and sixty million bushels, or 2.2 per cent, are handled by the starch factories. About forty million bushels, or about 1.5 per cent, of the corn crop is used in the manufacture of alcohol, lye hominy and in miscellaneous ways.

Dry Process

The corn meal mills manufacture the meal by what is known as the dry process. In the early days of corn milling, the entire kernel was ground. This made an excellent quality of corn meal, although some people objected to it because of the fine particles of hull. The greatest objection, however, was the presence of the germ in the meal, which made the meal rancid if kept a great length of time. Modern corn milling, therefore, involves degerminating the corn as its first step. The corn is sprayed with water or treated with steam until it has a moisture content of about 20 per cent, after which it goes into a machine with a rapidly revolving core, which results in breaking up the kernel in such a way as to loosen the hull and the germ but not to grind the starch. By mechanical processes, the hard starch is separated and ground into the commercial corn meal as we know it today, or, as some people call it, "hominy grits." If the meal is ground extremely finely, it makes what is known as corn flour, which can be mixed with wheat flour to produce a product which is just as good as pure wheat flour, although the bread made from it does not rise quite as much.

The soft white starch is mixed with the hulls, which are commercially known as corn bran, to make what is known as hominy feed. Extensive experiments with hominy feed in Iowa and Indiana, indicate that it has practically the same value for hogs as shelled corn. The germs are sometimes ground and mixed with the hominy feed; but in the more up-to-date plants, the oil is pressed out. The oil cake which is left after pressing out the oil is generally mixed with the hominy feed. Under average conditions, a bushel of corn, under the dry process, produces about 22 pounds of corn meal, 33 pounds of hominy feed, and one-half pound of oil.

In the manufacture of corn flakes, the dry process is used until the coarse particles of horny starch are separated out. These are rolled

out and toasted. Most of the corn flakes are manufactured by three large plants at Battle Creek, Michigan. They use about 10,000,000 bushels of corn annually.

Wet Process

The starch factories use only about one-third as much corn as the corn meal mills, but the process is far more complicated, and the products are much more extensively used in a wide variety of industries. The method of manufacture is known as the wet process. A bushel of corn as manufactured in a starch factory by the wet process produces about 32 pounds of starch, 15 pounds of gluten feed, 1.5 pounds of corn oil and 1.5 pounds of corn oil cake meal. Of the 32 pounds of starch which are obtained from the ordinary bushel of corn, only about 12 pounds are usually sold by the starch factories in the form of starch. Most of the rest (about 20 pounds) is usually converted into corn syrup. Twenty pounds of corn starch make 24 or 25 pounds of corn syrup or glucose. About two pounds of the original 32 pounds of starch obtained from a bushel of corn are made into a corn sugar. Both corn syrup and corn sugar are extensively used in candy making, ice cream, preserving, etc. Of the sugar used in commercial candies, over one-third comes from corn. People in the United States who eat candy are patronizing the farmers of the Corn Belt to almost as great an extent as they are the planters of Cuba and Hawaii.

The wet milling process of corn manufacture is briefly as follows:

The corn first goes through a very thorough purification process by which dust, particles of corn cobs, nails and other impurities are removed. The corn is then steeped for about thirty-six hours in lukewarm water to which is added a small amount of sulphurous acid. This is necessary for it prevents fermentation, and also softens the corn, allowing a better separation to take place later on in the process. Most of the sulphurous acid is lost in the steps to follow: The steeped corn is fed into disintegrator steel mills, which crush the kernel but do not grind it. In this crushing the elastic germ remains unbroken and is easily separated from the remainder of the kernel. This is done by passing the crushed mass into "germ separator tanks," in which the germs, containing 60 per cent oil, rise to the top and are removed by a mechanical skimming apparatus. They are then thoroughly washed with water in rotating sieves to remove all traces of gluten and starch which may adhere to them.

The lumps of endosperm, hulls and loose particles of gluten and starch leave the separator tanks as tailings. This mass, coming from the bottom of the tanks, goes to the buhr mills, in which it is ground fine. It is then pumped over revolving silk sieves, where the hulls are removed and washed free from adhering gluten and starch, which pass through the fine silk cloth. The hulls, separated in the rotating sieves, are partly dehydrated and then thoroughly dried in steam dryers. They are later mixed with the gluten to form "gluten feed."

The mixture of starch and gluten suspended in water and passing through the sieves during the separation of both the germ and hulls, is run off at a regulated speed over long sloping troughs or tables. The starch being the heavier settles down into a solid cake, while the gluten suspension runs off the tables as tailings. The gluten liquor is collected in cone settlers where it is concentrated. The concentrated liquor is filter pressed and the resulting gluten (containing about 55 per cent protein) is dried and mixed with the hulls to form "gluten feed." To this gluten feed, before it is finally dried, is also added the concentrated steepwater, containing food materials which were dissolved out from the corn.

The somewhat solid cake of starch on the tables is removed by churning it up with a heavy stream of water. The starch liquor is filter pressed and the press cake rapidly dried into so-called "pearl starch," or pulverized and sold as powdered starch. For food purposes the starch is subjected to a number of washings before it is filter pressed, dried and powdered. These starches find their way into the market in bulk or in package form under the various trade names such as "Buffalo," "Kingsford Silver Gloss," "Duryea" or "Argo Gloss." Some of these starches are also made in crystal and in lump form. For laundry purposes there are prepared various grades called "thin boiling starches." Dextrines, used for making adhesives, sizing mixtures, etc., are made from powdered starch.

Dent corn, which is used mostly by the corn products industry, contains practically no sugar of any kind. Corn sugars and syrups are made by changing, by hydrolysis, the starch into the sugar or syrup, as the case may be. The process is briefly as follows: The starch liquor from the tables is first rewashed and then pumped into large vessels capable of being subjected to high pressures. The starch liquor is heated in these convertors with a very small amount of muriatic or hydrochloric acid under a pressure of about thirty-five or forty-five pounds, depending on whether it is desired completely to change the starch into sugar or only partially to form corn syrup. After this treatment the liquor (corn sugar or syrup) is blown into large tanks, in which the muriatic acid is neutralized with soda ash. As a result of the action between the acid and soda ash there is formed a small amount of common, harmless salt which is found in traces in all corn sugar products. After the neutralization the liquors are passed through a mechanical separation to remove the suspended matter present. To remove color these liquors are run over bone black filters. They are then partially concentrated in vacuum pans, again decolorized with bone black and finally concentrated by evaporation to the desired gravity.

The sugar liquor, after concentrating, is run into barrels, where it solidifies on cooling. These grades are used in many industries, among them the brewing, tanning and sugar color making. A higher grade sugar is made by running out the concentrated sugar liquors into large

boxes in which it solidifies. When hardened to a certain degree it is cut into small rectangular pieces. These, after proper curing, are wrapped in press cloths and placed in hydraulic presses, where they are subjected to a high pressure. The mother liquor, containing non-crystallizable matter, is forced out. This is called "hydrol" and corresponds to molasses in the cane sugar industry. The sugar cakes are then broken up, dried and pulverized. Corn sugar produced in this way is used in baking, manufacture of chewing gum, candies, etc.

Recently a new method for the production of an extremely pure corn sugar was tried out and found to be successful. In this method the sugar is crystallized out of the sugar liquor under slow motion, and under conditions paralleling those in use for producing white cane sugar. This resulted in a sugar of 99.5 per cent purity, i. e., 99.5 per cent pure dextrose. Previously the highest purity obtained in the finished sugar was 95 per cent. This sugar, "Refined Cerelose," is only about three-fifths as sweet as cane sugar, but carries, pound per pound, fully as much value as cane sugar, and is more digestible and healthful. A slightly more purified sugar has been used recently by physicians for baby feeding experiments. The corn sugar was found to give wonderful results in this connection, and, as a result many physicians are prescribing it continuously. "Refined Cerelose" has been found to be satisfactory for use in confectionery, ice cream, and baking. Its use for condensed or evaporated milk will also prove satisfactory.

Corn Oil

The germs after drying, are conveyed to cylindrical steel mills and ground to a fine powder. This oil meal is heated and passed through presses. The cake from which the oil has been pressed is ground up and sold as oil cake meal. The oil run off from the presses goes through a refining process, in which it is filtered, neutralized, decolorized and clarified, deodorized with steam, chilled and again filtered. This results in the edible corn oil of commerce. It makes an excellent salad oil, which many housewives believe to be fully equal to the more expensive olive oil. It is the most valuable product on a pound basis that is produced from corn.

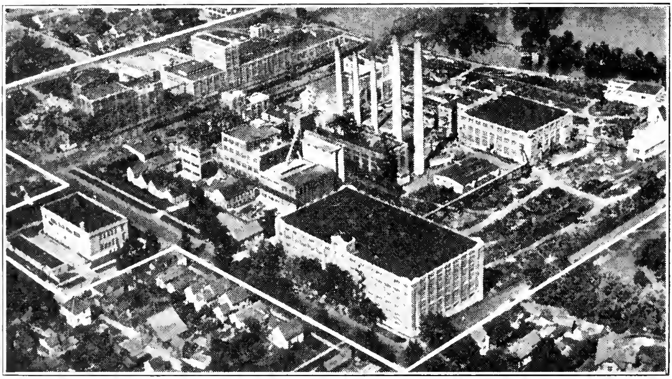
Corn Products Refining Company

For many years the starch factories seemed to find it difficult to get on a sound financial basis. Stability has been brought into the industry in recent years by the consolidation of a number of plants under the name of the Corn Products Refining Company. This company has made a great success, and has done much toward increasing the consumption of corn products generally, largely by popularizing its products with the retail trade under trade names, such as "Karo," "Argo," "Cerelose," "Mazola," etc. Previous to 1915, the common stock of this corporation sold customarily on the New York Stock Exchange for considerably less than $50 a share, whereas, since 1920 it has sold most of the time for considerably over $100 a share. This company probably

buys more bushels of corn annually than any other corporation in the world. It has large plants at Argo, Ill.; Pekin, Ill.; Kansas City, Mo., and Edgewater, N. J. There are three independent companies in the state of Iowa, one at Cedar Rapids, one at Clinton, and another at Keokuk, with an approximate grind capacity of 15,000,000 bushels annually. The three Iowa plants together have a capacity almost equal to the Argo plant of the Corn Products Company.

Types of Corn for Wet and Dry Processes

It should be noticed that the corn meal mills and the starch factories are best served by different types of corn. While both appreciate a corn high in oil, the corn meal mills' chief product is made out of the



The Penick & Ford Corn Products Plant, at Cedar Rapids, Iowa. Wet process plants use over a million gallons of water daily, and must have an abundant water supply.

horny starch, whereas the starch factories' chief product is made out of the soft starch together with a part of the horny starch. The corn meal mills sell the soft starch and the hulls as an animal feed, whereas the starch factories sell the glutinous part of the hard starch and hulls as animal feed. It would seem, therefore, that a flinty corn rich in protein, would serve the corn meal mills best, whereas, a rather soft corn low in protein would serve the starch factories better.

Miscellaneous Products

A bushel of corn can be made into 2.5 gallons of alcohol, and it is possible that a hundred years from now corn alcohol will be extensively used instead of gasoline to furnish motive power for automobiles and trucks. Roughly estimated, corn at 90 cents a bushel can produce alcohol to compete with gasoline at 50 cents a gallon. Before the war, about

23,000,000 bushels of corn were used annually in the distillation of alcohol, but since the Volstead act only three or four million bushels have been reported to the revenue officers as being used in the distillation of alcohol. One of the less important but very interesting corn industries is the manufacture of cob pipes. In south-central Missouri, they grow one of the largest-eared varieties of corn in existence. The cobs of this Missouri cob-pipe variety sell to the pipe factory for about as much as ordinary ear corn which carries the kernels as well as the cobs. About $500,000 worth of Missouri cob pipes are sold annually.

The cobs of ordinary corn are used to some extent in the manufacture of a dye known as furfural. As yet, however, no very strong market for ordinary corn cobs has been found. Many miscellaneous products of little importance are made of the stalks and husks.

The ten per cent of the corn crop used by American corn industries plays a more important part in making the corn market than many people suspect. These industries buy a large part of the corn which comes to such markets as Chicago, and the competition which they furnish plays an important part in setting the price. As the years go by, and people become more and more familiar with the good qualities of food products made out of corn, it is probable that these corn industries will be able to compete more and more successfully with hogs in the furnishing of a satisfactory market for the Corn Belt farmer's corn.

CHAPTER 38

CORN GROWING OUTSIDE OF THE CORN BELT

THE outstanding corn growing areas of the world are characterized by a mean temperature of 56 to 70 degrees at planting time, a mean temperature of 67 to 81 degrees at tasseling time, a rainfall of at least five inches, one year with another, for the fifty-day period centering around tasseling time, and a soil moderately rich and fairly easy to cultivate. In the best corn producing sections of Iowa and Illinois, the mean temperature at planting time is around 61 degrees and at tasseling time around 75 degrees; the rainfall averages about eight inches, one year with another, during the fifty days centering around tasseling time, and the soil is unusually rich and easily cultivated. There are very few large bodies of land in the world which possess the same combination of factors so favorable to corn as the Corn Belt. Some of the other corn growing sections are described in the following:

Corn Growing in the Cotton States

Probably more corn is produced in the cotton states than any other one section outside of the Corn Belt. Ordinarily, about 35,000,000 acres are planted in these states, as compared with about 50,000,000 acres in the Corn Belt. Because of poor soil, however, the yield averages less than twenty bushels per acre, and the total output of corn in the cotton South is less than half as much as in the Corn Belt. Nearly all of the corn raised in the cotton South is consumed at home. Practically none of it reaches such primary markets as Kansas City, St. Louis and Chicago.

From one-fourth to one-third of the improved land of the cotton states is put into corn. Cotton has first place in the eyes of the southern farmers, but corn is a close second.

In such cotton states as South Carolina, Georgia, Mississippi and Louisiana, the corn is generally planted during March or early April, but may be planted as late as June or even July. Plowing is customarily done in the form of beds three and one-half to five feet wide. First a double moldboard plow, called a middle buster, is run down between where the rows of corn or cotton were the previous year. Then ground on either side of the furrow thus made is turned over with a single shovel turn plow, the final result being a series of beds about four feet wide, with furrows five or six inches deep in between. The tops of the beds are harrowed off and the corn is usually planted on the center of the beds with a one-horse corn planter. In some cases, the corn is planted in the furrows between beds. In the western part of the Cotton Belt,

where the rainfall is lighter, they often use western Corn Belt methods and plow level or list. Listing also seems to be growing in favor in the eastern part of the Cotton Belt.

The rate of planting in the South is usually only about one-half as thick as in the North, except on rich bottom lands. On exceptionally poor soil, the rows may be spaced six feet apart and the kernels two feet apart in the row.

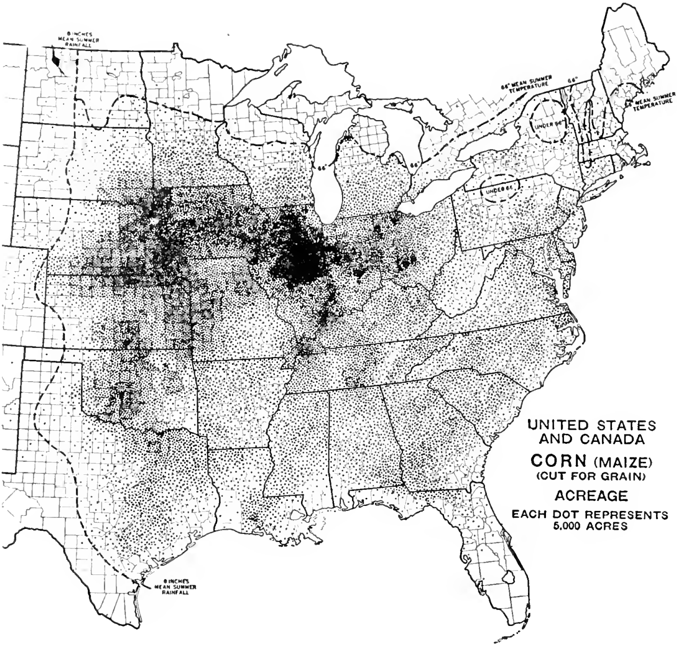
Cultivation is much the same as in the North, but much of it is with single-horse cultivators. In parts of the South, considerable hand hoeing is done at the rate of about two acres a day.

An extreme example of southern prolific corn.

Because many of the soils are poor, corn is more often fertilized in the Cotton Belt than it is in the Corn Belt. A mixture which often gives very good results is one hundred pounds of acid phosphate and two hundred pounds of cottonseed meal, applied either at the time of planting or just before the corn is planted. Sometimes fifty or a hundred pounds of muriate of potash are added to this mixture.

The southern corn root worm is a very serious pest in the South, and often damages the corn planted in March and early April very severely. Especially is this true in cold, wet seasons. Corn planted in May ordinarily is not bothered. On well-drained land, where this pest usually causes but little trouble, it seems to be the best policy to plant in March or early April.

Throughout the cotton states, the prolific varieties which average nearly two ears to the stalk and oftentimes as many as three, are far more popular than the single-ear varieties which are almost universally grown in the Corn Belt. The ears of these prolific varieties are only about three-fourths as large as the ears of the single-ear sorts, but under southern conditions, the average prolific plant yields about 15 per cent more than the average plant of the single-ear type. The typical ear of prolific corn carries twelve or fourteen rows and the kernels are rather flinty with a very smooth dent. The husks of well-bred southern varieties fit tightly to the corn and carry out well past the tip, this husk protection being valued in the South because of the corn ear worm and weevil, which cause very severe damage to varieties with loose husks.



Compare this map with the maps of the Argentine corn belt and the European corn belt. In each case, the dots represent 5,000 acres. In the United States, as in Argentina, very little corn is grown where the summer rainfall is less than eight inches. Note that corn is grown uniformly in the cotton states, but that the density of corn planting is not equal to that in the corn belts of Argentina and Europe. (Courtesy of the United States Department of Agriculture.)

Climatic conditions in the cotton states are quite favorable to corn, although the weather is frequently too dry at tasseling time for the best results. The rainfall is usually sufficient to produce an abundant crop, and the cotton states would undoubtedly be another Corn Belt if the soil were only richer. As it is, nearly all of the records of corn yielding over two hundred bushels per acre have come from the South, such results being obtained by planting corn thickly on land heavily fertilized. The corn yields of the South will increase in the future as the South grows more soy beans, cowpeas, velvet beans, crimson clover, peanuts and live stock. As long as the cotton states plant over 33,000,000 acres of land to cotton every year, it is doubtful if they will ever produce much more than twenty bushels of corn per acre on the average.

Corn Growing in Argentina

The Argentine corn belt is located about six hundred miles nearer the equator than the American corn belt. At planting time, in November (some corn is planted as early as late September and some as late as December), the temperature is usually about five degrees higher than in the Corn Belt during May. At tasseling time, in January, the temperature is about the same as in the corn belt of the United States. The rainfall during the fifty days centering around tasseling time averages about the same as in our corn belt, but there is a little greater danger of really severe drouth. Moreover, there is occasional severe damage caused by the langosta (a grasshopper), which comes in droves from northern Argentina and southern Brazil. The soil is deep and exceptionally rich.

Year by year, since 1909, the acreage, the average acre yield (in bushels), and the exports from Argentina (in bushels), have been as follows:

	Av. Acre Yield	Acreage (000 omitted)	Exports (000 omitted)
1909	24.3	7,349	89,499
1910	23.7	7,425	104,727
1911	3.5	7,945	4,923
1912	35.2	8,456	190,351
1913	20.9	9,464	189,328
1914	25.5	10,260	139,458
1915	31.3	10,386	170,488
1916	16.3	9,928	113,140
1917	6.5	8,969	35,190
1918	19.6	8,715	26,170
1919	27.0	8,252	97,850
1920	31.3	8,184	173,642
1921	28.5	8,090	111,603
1922	24.1	7,344	109,101*
1923	19.5*	7,851*	

*Preliminary figures.

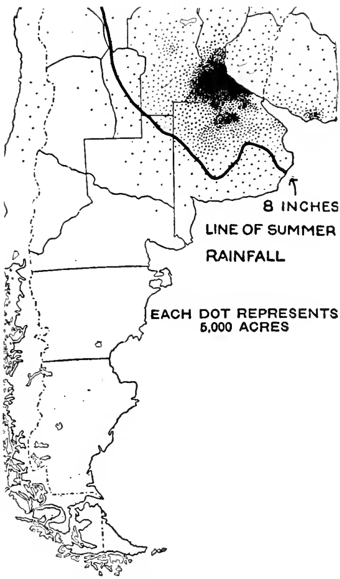
Corn production in Argentina from 1911 to 1922 averaged 200,000,-000 bushels, and the exports averaged 113,000,000 bushels. Argentine live stock apparently consumes on the average about 85,000,000 bushels annually, or less than half the crop, whereas in the United States live stock consumes about 80 per cent of the crop. The great barriers to increased live stock consumption of corn in Argentina are the splendid alfalfa pastures and the fact that occasionally, as in 1911 and 1917, the crop is almost an entire failure. In such years, a live stock industry built on corn suffers the greatest inconvenience. The possibilities of Argentina as a pork-exporting nation are a little uncertain as long as there is the probability of almost complete crop failure once in every five or ten years. In this respect, Kansas and Argentina are much alike.

Argentine corn is planted in rows about two and a half feet apart, with the stalks about fifteen inches apart in the rows. American listers are much in favor in the southwestern part of the Argentine corn belt.

The Argentine chacarero (share renter) husks into baskets and dumps the baskets when full into sacks at the end of the field.

They use a three-row corn planter in some sections, but set it to drill rather than check. Some of the more backward farmers broadcast their corn and plow it under. Argentine corn is not cultivated as much as

The Argentine corn crib (troje) has sides made of corn stalks.



Argentine corn production is centered in northern Buenos Aires, southwestern Entre Rios, southern Santa Fe and southeastern Cordoba. Very little corn is grown southwest of the eight-inch line of summer rainfall. Rosario, the Chicago of Argentina, on the River Plata, is a port for ocean going vessels and is located in the center of densest corn production. (Courtesy of United States Department of Agriculture.)

American corn. Corn husking is at its height in April, May and early June. The corn is husked into baskets about the size of large waste baskets, and then poured into large sacks, and the sacks are dragged to the edge of the field, where they are picked up with a team and wagon, and the corn is hauled to a crib the sides of which are made of corn stalks. Many of these are round and much like the temporary, uncovered fence cribs seen here and there in the Corn Belt.

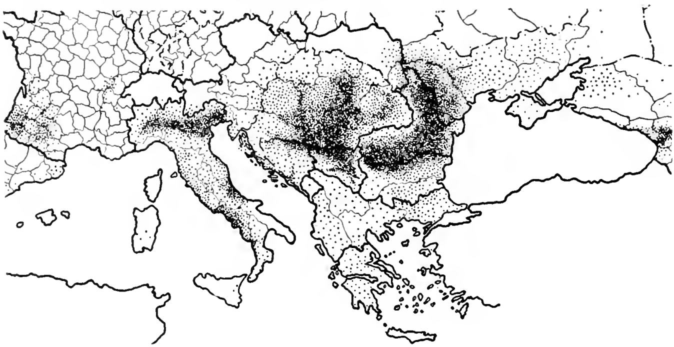
Much of the surplus corn is shelled on the farm and shipped by rail to Rosario (the Chicago of Argentina), which is about two hundred miles away from the typical farm. Rosario is an ocean port, and the cost of shipping from Rosario to either New York or Liverpool is usually slightly less than the cost of shipping from Chicago to New York. The Argentine farmer really has lower transportation costs separating him from most of the big markets of the world than the American farmer.

The most popular Argentine corn is the Canario, a twelve-rowed yellow flint with ears seven or eight inches long. The Piamontese and Colorado are almost equally popular and are very similar except that the yellow color is so deep as to suggest a tinge of red. The kernels of Argentine flints are much smaller and shinier than the kernels of New England flints. In one hundred pounds of dry corn, the Argentine flints typically carry one and one-half to two pounds more of protein, one-half pound more of fat, and two pounds less of starch than our Corn Belt dents. Argentine shelled corn often weighs 60 pounds to the bushel and occasionally as much as 64 pounds.

The stalks of Argentine flints are very sturdy and decidedly wind resistant. The ears have large shanks and close fitting husks and are much harder to husk than Reid Yellow Dent. Argentine varieties are apparently well adapted to machine husking. Ordinarily, the Argentine

varieties yield about three-fourths as well as Reid Yellow Dent on the same land.

In Argentina there are about 18,000,000 acres of alfalfa, 14,000,000 acres of wheat, 8,000,000 acres of corn, 4,000,000 acres of flax and 3,000,000 acres of oats. It is possible for Argentina to put about 25,-



In this map, as in the Argentine and United States maps, one dot equals 5,000 acres. Most of the European corn is grown in the Danube region and in northern Italy. The European corn belt centers around latitude 48, or farther away from the equator than either the United States or the Argentine corn belt. (Courtesy of United States Department of Agriculture.)

000,000 acres into corn year after year, but it is not likely that this will be done until they have a different type of corn farmer. The Argentine corn farmer is typically a share renter (chacarero), who lives in a hovel and keeps no live stock. He ordinarily handles one hundred acres of corn and nothing else. A man of this sort will not give corn the intensive care which will enable it to compete effectively with wheat and alfalfa for the use of the land.

During the five-year period before the war, Argentina furnished about 50 per cent of the corn which moved across international boundaries. The Danube basin in southeastern Europe furnished about 30 per cent, and the United States about 15 per cent. Because Argentine corn is found to such an extent on the world market, it is worth while studying the Argentine corn situation with some care.

Corn Growing in the Danube Basin

In the Balkan States, Hungary and Bessarabia is located the European corn belt. The total acreage is about 17,000,000 acres, or about as much land as is put in corn in Iowa and Missouri put together. Since the peace treaty, half of this corn land is in Greater Roumania. The yield is typically around twenty bushels per acre, with occasional years of failure when the yield is only ten bushels. The summer temperature

averages about three degrees less than in central Iowa and Illinois. The annual rainfall is about twenty inches, or about the same as western Nebraska.

Drouth, insects, floods and hail often cause severe damage. Corn is customarily grown in rotation with wheat, moderately early flint varieties being preferred, so that they can be gotten off in time to seed winter wheat. The flints seem to be largely of the twelve-row, small seeded type, somewhat similar to the Argentine flints. In large sections of the Balkans they broadcast the corn in April and plow it under, and then when the corn and weeds are about three inches high they go through with a large hand hoe and cut out the weeds and surplus corn and hill up the earth around each plant. Very few corn planters are used, even on the larger estates, where scientific methods of growing wheat are general. Where the land is plowed before planting, the customary method of planting is to drop by hand into holes made with a pointed stick.

The corn is quite commonly harvested by cutting the stalks off with a hoe and finally husking and storing in a crib made of woven saplings and thatched with straw.

In Hungary, the methods are possibly a little better than this, but on the whole the Danube corn is produced by a very ignorant class of peasants who know absolutely nothing about modern methods of corn growing. A large part of the Danube corn crop, which is not exported, is consumed by the peasants, the per capita consumption being about twelve bushels, or probably higher than that of any other part of the world. The extent to which the Danube corn is eaten by human beings may explain why the small seeded flints are so extensively grown.

Before the war, the surplus Danube and Argentine corn quite largely determined corn prices at Liverpool, Amsterdam and Hamburg. Dent corn from the corn belt of the United States occasionally had some influence in years of exceptionally large crops.

Corn Growing in Mexico

Mexico, the original home of corn, until the death of Diaz grew a larger acreage than any other nation aside from the United States. A large percentage of the crop land of southwestern Mexico is put in corn. The yield is low and the crop is consumed entirely at home by people (in the form of tortillas) rather than by animals.

Corn in Western Europe

Italy with 4,000,000 acres, Spain with 1,500,000 acres, and southern France with 1,000,000 acres, are the chief corn growing countries of western Europe. The small seeded flints are in greatest favor. Much of the Italian corn is grown under irrigation. The crop is used chiefly as food by the peasants. All of western Europe put together produces less than half as much corn as Iowa. Italy, the leading corn country of western Europe, imports several million bushels annually.

Corn Growing in South Africa

In the southeastern part of South Africa is a large section of land about a mile above sea level where the season is long and the summer rainfall is just right for corn. The temperature is ideal except that during the middle of the summer it averages around 68 degrees, or about four degrees too low. The chief drawback is a rather poor soil. Nevertheless, wonderful progress in corn growing has been made since 1900, and there is a possibility that South Africa may rank eventually with Argentina and the Danube basin in providing western Europe with corn. The favorite South African variety is Hickory King, a large seeded, late maturing, twelve-row dent, which is also popular on the poorer soils of the northern edge of the Cotton Belt.

Modern corn growing methods are employed in South Africa and some very good English and Boer brains are continually at work on the problem of increasing South African corn production. The South Africans seem to have their eyes fixed quite firmly on the export market.

Corn Growing in Asia and Africa

Nearly 100,000,000 bushels are grown every year in India, but it is all consumed at home. Considerable corn is also grown in China. Corn in Asia is infected with a serious disease which has not yet reached the United States.

Egypt grows on her fertile irrigated Nile soil about 60,000,000 bushels annually, but none of it leaves the country.

The Negro tribes of interior Africa have grown considerable corn for home consumption for several centuries. There is no prospect, however, that any part of Africa aside from southeastern South Africa, will ever produce much corn for export.

CHAPTER 39

CORN STATISTICS

THE statistical tables in the following are compiled (except where otherwise noted) from the United States Department of Agriculture publications. Students who wish to keep these tables up-to-date may consult future Year-books of the Department of Agriculture, and Weather, Markets and Crops.

Table XVI—World Corn Production Before and Since the War

(Figures given in thousands of bushels)

NORTHERN HEMISPHERE

Country	Average 1909-1913	1921	1922
North America—			
Canada*	17,297	14,904	13,798
United States*	2,712,364	3,068,569	2,890,712
Mexico*	164,657	61,021	78,737
Guatemala	....	6,666	4,828
Total North American countries marked *	2,894,318	3,144,494	2,983,247
Europe—			
France*	a 22,289	10,393	13,621
Spain*	26,548	24,897	26,832
Portugal	15,000	11,374	
Italy*	a 100,349	b 96,775	b 76,768
Switzerland*	113	217	185
Austria*	a 14,536	2,521	b 3,703
Czechoslovakia*	....	9,432	8,996
Hungary*	a 168,081	31,703	32,493
Yugoslavia*	....	73,788	57,400
Serbia, Bosnia-Herzegovina and Croatia-slavonia*	a 62,112		
Greece*	c 5,952	7,874	
Bulgaria*	a 28,219	24,172	19,802
Roumania*	a 100,620	d 106,333	94,207
Poland	....	2,266	2,776
Russia, including Ukraine and Northern Caucasia	a 70,222		
Total European countries marked *	522,867	380,231	334,007
Africa—			
Morocco, Western	....	5,886	4,564
Algeria*	461	354	276
Tunis	e 228	e 354	
Egypt	64,220	67,165	
Total African countries marked *	461	354	276

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Table XVI—World Corn Production Before and Since the War

(Continued from Preceding Page)

Asia—			
India, British*	87,240	83,320	96,240
Japan	3,637	4,281	
Chosen	2,236		
Philippines*	7,446	16,734	14,645
Total Asiatic countries marked *	94,686	100,054	110,885
Total northern hemisphere countries marked *	3,512,332	3,625,133	3,428,415

SOUTHERN HEMISPHERE

Country		Average 1908-09 to 1912-13	1921-22	1922-23
Chile		1,390	2,030	
Uruguay		6,027	4,805	
Argentina*		174,502	176,171	153,141
Union of South Africa	f	32,588	43,360	50,390
Southern Rhodesia*	c	1,404	2,367	5,000
Java and Madura		....	46,821	49,612
Australia		10,264		
New Zealand		493	488	
Total southern hemisphere countries marked *		208,494	221,898	208,531
Total world countries marked *		3,720,826	3,847,031	3,636,946

*Indicates countries reporting for all periods.
a—Old boundaries.
b—Includes new territory.
c—One year only.
d—Winchester bushels.
e—Includes sorghum.
f—Three-year average

Table XVII—World Corn Acreage Before and Since the War

(Figures given in thousands of acres)

NORTHERN HEMISPHERE

Country	Average 1909-13	1921	1922	1923
North America—				
Canada*	309	297	318	
United States	104,229	103,740	102,428	103,112
Mexico*	11,554	2,545	3,212	
Guatemala	....	310	468	
Total North American countries marked *	116,092	106,582	105,958	
Europe—				
France*	a 1,155	814	790	781
Spain*	1,134	1,178	1,159	
Portugal	....	714		
Italy*	a 3,931	b 3,822	b 3,824	
Switzerland*	3	5	4	
Austria*	a 761	112	b 148	
Czechoslovakia*	....	385	395	
Hungary*	a 6,038	2,167	1,716	
Yugoslavia*	....	4,646	4,786	
Serbia, Bosnia-Herzegovina and Croatia-Slavonia*	a 3,059			
Greece	c 273	494		
Bulgaria*	a 1,544	1,418	1,552	
Roumania*	a 5,143	8,510	8,411	
Poland	....	132	183	
Russia, including Ukraine and northern Caucasia	a 3,923			
Total European countries marked *	22,768	23,057	22,785	
Africa—				
Morocco, Western	....	610	535	
Algeria*	34	24	19	
Tunis	d 43	d 55		
Egypt	1,857	2,086		
Total African countries marked *	34	24	19	
Asia—				
India, British*	6,340	6,164	6,186	
Japan	130	153		
Chosen	156			
Philippines*	992	1,344	1,329	
Total Asiatic countries marked *	7,332	7,508	7,515	
Total northern hemisphere countries marked *	146,226	137,171	136,277	

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Table XVII—World Corn Acreage Before and Since the War

(Continued from Preceding Page)

SOUTHERN HEMISPHERE

Country	Average 1908-09 to 1912-13	1921-22	1922-23	1923-24
Chile*	56	63	68	
Uruguay	551	674		
Argentina*	8,128	7,344	7,851	
Union of South Africa	2,171			
Southern Rhodesia	....	182	215	
Java and Madura	....	3,690	3,880	
Australia	352			
New Zealand	10	11		
Total southern hemisphere countries marked *	8,184	7,407	7,919	
Total world countries marked *	154,410	144,578	144,196	

*Indicates countries reporting for all periods except 1923.
a—Old boundaries.
b—Includes new territory.
c—One year only.
d—Includes sorghum.
e—Three-year average.

Table XVIII—World Corn Trade

(Figures given in thousands of bushels)

Country	Aver. imports, 1909-13	Aver. exports 1909-13	1920 imports	1920 exports	1921 imports	1921 exports
Principal exporting countries—						
Argentina	2	115,749	....	173,642	....	111,603
British South Africa	257	4,115	637	5,149	23	20,133
Bulgaria	44	9,307	(1)	4,185	(1)	696
Roumania	176	38,966	429	17,329	(1)	30,280
Russia	335	30,034				
United States	1,226	45,054	7,784	21,230	164	132,186
Uruguay	5	210	....	(1)	....	209
Principal importing countries—						
Austria-Hungary	13,877	268	* 5,124	....	* 6,699	
Belgium	25,801	8,130	10,513	2,327	19,386	7,129
Canada	10,629	25	10,793	113	12,455	110
Cuba	2,746	(1)	3,217			
Denmark	11,440	6	9,822	4	18,575	434
Egypt	471	61	948	1	1,604	397
France	18.708	82	17,609	858	12,466	600
Germany	32,160	1	16,099	(1)		
Italy	14,895	206	12,599	4	17,965	11
Mexico	4,404	82				
Netherlands	29,580	8,750	15,566	37	35,643	355
Norway	1,079	....	2,623	....	3,528	
Portugal	1,674	5				
Spain	9,775	44	7,719	188	11,906	576
Sweden	1,476	26	1,505	41	4,186	
Switzerland	3,987	1	963	(1)	5,107	
United Kingdom	82,976	96	71,057	67	78,194	65
Other countries	3,268	9,817	3,729	7,376	2,942	1,856
Total	270,991	271,026	198,736	232,551	230,843	360,640

(1) Less than 500. *Austria only.

Table XIX—Corn Exports from the United States by Countries to Which Exported

(Figures given in thousands of bushels)

Country	Average 1910-14*	1918	1919	1920	1921	1922
Belgium	1,388	3,467	1,010	72	1,560	4,920
Denmark	2,494	....	335	173	5,965	6,519
France	604	1,370	(1)	191	548	3,818
Germany	5,232	....	....	1,324	12,729	30,282
Italy	12	2,196	....	....	248	2,059
Netherlands	5,111	46	100	424	17,843	21,729
Norway	45	....	....	(1)	95	1,318
Spain	2	....	....	....	50	2,388
Sweden	....	....	....	....	792	663
Portugal	153					
Russia in Europe	1	....	....	....	....	5,876
United Kingdom	10,906	15,658	948	2,707	15,811	28,660
Ukraine	....	....	....	....	....	2,836
Mexico	2,501	2,736	134	771	11,872	3,351
Cuba	2,301	1,074	1,965	1,894	2,309	2,764
Canada	8,379	13,229	6,542	10,065	58,583	45,339
Other countries	681	123	159	140	570	1,087
Total	39,810	39,899	11,193	17,761	128,975	163,609

*Fiscal years ending June 30. (1) Less than 500.

Source—Compiled from publications and records of the Department of Commerce, originating in the customs records of the Treasury Department.

Table XX—Corn Imports Into the United Kingdom

(Figures given in bushels)

Country	Average 1909-13	1921	1921
Russia	7,488,758	....	(1)
Bulgaria	939,400		
Roumania	10,652,760	6,347,400	1,018,000
Turkey in Europe	164,080	....	(1)
Turkey in Asia	89,120	....	(1)
Egypt	17,120	....	(1)
Morocco	23,760	....	(1)
United States	13,580,470	13,467,200	29,492,200
Uruguay	59,720	27,200	(1)
Argentina	45,495,513	31,655,200	25,677,760
British West Africa	202,240	3,200	(1)
British South Africa	1,669,978	8,507,166	(1)
British India	1,421,760	103,800	(1)
Canada	1,085,320	*11,578,400	*11,328,850
Other countries	317,368	1,825,000	6,883,394
Total	83,207,367	73,514,566	74,400,204

*Most of this was United States corn shipped by way of Canada.

(1) If any, included in "other countries."

Source—Annual statement of the trade of the United Kingdom with foreign countries and British possessions.

Table XXI—Corn Acreage, Production, Value and Exports in the United States, 1849-1922

Note—Figures in bold face are census returns; figures in roman are estimates of the Department of Agriculture. Estimates of acres are obtained by applying estimated percentages of increase or decrease to the published acreage of the preceding year, except that a revised base is used for applying percentage estimates whenever new census data are available. Acreages have been revised for years 1890-1908, so as to be consistent with the following as well as the preceding census acreage, and total production and farm values are adjusted accordingly.

Year	Acreage (in thousands)	Average yield per acre (bushels)	Production (1,000 bushels)	Av. farm price per bu., Dec. 1 (cts.)	Farm value, Dec. 1 (1,000 dollars)	Dom. exp., inc. corn meal, fiscal year beg'g. July 1 (bus.)
1849			**592,071**			7,632,860
1859			**838,798**			4,248,991
1866-1875	37,216	26.1	969,948	46.9	454,535	24,242,396
1876-1885	61,671	25.4	1,564,992	39.5	617,780	69,091,110
1886-1895	74,274	23.8	1,769,616	36.7	648,785	59,293,085
1896	86,560	28.9	2,503,484	21.3	532,884	178,817,417
1897	88,127	24.3	2,144,553	26.0	558,309	212,055,543
1898	88,304	25.6	2,261,119	28.4	642,747	177,255,046
1899	**94,914**	25.9	2,454,628	29.9	734,916	213,123,412
1900	95,042	26.4	2,505,148	35.1	878,243	181,405,473
1901	94,636	17.0	1,613,528	60.1	969,285	28,028,688
1902	95,517	27.4	2,619,499	40.1	1,049,791	76,639,261
1903	90,661	25.9	2,346,897	42.1	987,882	58,222,061
1904	93,340	27.1	2,528,662	43.7	1,105,690	90,293,483
1905	93,573	29.4	2,748,949	40.8	1,120,513	119,893,833
1906	93,643	30.9	2,897,662	39.3	1,138,053	86,368,228
1907	94,971	26.5	2,512,065	50.9	1,277,607	55,063,860
1908	95,603	26.6	2,544,957	60.0	1,527,679	37,665,040
1909	**98,383**	26.1	2,572,336	58.6	1,507,185	38,128,498
1910*	104,035	27.7	2,886,260	48.0	1,384,817	65,614,522
1911	105,825	23.9	2,531,488	61.8	1,565,258	41,797,291
1912	107,083	29.2	3,124,746	48.7	1,520,454	50,780,143
1913	105,820	23.1	2,446,988	69.1	1,692,092	10,725,819
1914	103,435	25.8	2,672,804	64.4	1,722,070	50,668,303
1915	106,197	28.2	2,994,793	57.5	1,722,680	39,896,928
1916	105,296	24.4	2,566,927	88.9	2,280,729	66,753,294
1917	116,730	26.3	3,065,233	127.9	3,920,228	49,073,263
1918	104,467	24.0	2,502,665	136.5	3,416,240	23,018,822
1919	97,170	28.9	2,811,302	134.5	3,780,597	16,728,746
1920*	101,699	31.5	3,208,584	67.0	2,150,332	70,905,781
1921	103,740	29.6	3,068,569	42.3	1,297,213	179,514,442
1922*	102,428	28.2	2,890,712	65.7	1,900,287	

*Acreage adjusted to census basis.

Table XXII—Corn Production and Distribution in the United States, 1897-1922

Year	Old stock on farms, Nov. 1 (1,000 bus.)	New crop, quantity (1,000 bus.)	Quality (per ct.)	Proportion merchantable (pr. ct.)	Quantity merchantable (1,000 bus.)	Total supplies (1,000 bus.)	Stock on farms Mar. 1, following (1,000 bus.)	Shipped out of Co. where grown (1,000 bus.)
1897-1901	166,809	2,195,795	83.3	85.6	2,005,697	2,362,604	823,739	424,894
1902-1906	91,662	2,628,334	88.1	82.2	2,170,417	2,719,996	1,045,965	596,400
1907	129,786	2,512,065	82.8	77.2	1,939,877	2,641,851	931,503	470,046
1908	69,251	2,544,957	86.9	88.2	2,244,571	2,614,208	999,235	565,510
1909	77.403	2,572,336	84.2	82.7	2,126,965	2,649,739	980,848	620,057
1910	113,919	2,886,260	87.2	86.4	2,492,763	3,000,179	1,165,378	661,777
1911	123,824	2,531,488	80.6	80.1	2,027,922	2,655,312	884,059	517.766
1912	64,764	3,124,746	85.5	85.0	2,654,907	3,189,510	1,290,642	680,831
1913	137,972	2,416,988	82.2	80.1	1,961,058	2,584,960	866,352	422,059
1914	80,046	2,672,804	85.1	84.5	2,259,755	7,752,850	910,894	498,285
1915	96,009	2,994,793	77.2	71.1	2,127,965	3,090,802	1,116,559	560,824
1916	87,908	2,566,927	83.8	83.9	2,154,487	2,654,835	782,303	450,589
1917	34,448	3,065,233	75.2	60.0	1,837,728	3,099,681	1,253,290	678,027
1918	114,678	2,502,665	85.6	82.4	2,062,041	2,617,343	855,269	362,589
1919	69,835	2,811,302	89.1	87.1	2,448,204	2,881,137	1,045,575	470,328
1920	139,083	3,208,584	89.6	86.9	2,789,720	3,347,667	1,564,832	705,481
1921	285,769	3,068,569	84.0	87.5	2,684,634	3,353,338	1,305,559	587,893
1922*	177,287	2,890,712	85.0	88.3	2,553,290	3,067,999	1,087,412	515,236

*Preliminary estimate.

Table XXIII—Monthly Marketings of Corn by Farmers, 1917-1922

Estimated amount sold monthly by farmers of the United States (millions of bushels)

Year	July	August	September	October	November	December	January	February	March	April	May	June	Season
1917-18	34	26	22	24	56	78	91	103	88	45	36	37	640
1918-19	27	28	35	27	30	49	61	30	31	34	33	25	410
1919-20	20	25	21	25	40	66	57	42	38	26	33	47	440
1920-21	35	36	45	35	46	74	93	76	58	36	55	61	650
1921-22	28	42	49	39	38	71	80	72	43	27	44	43	576
Average	29	31	34	30	42	68	76	65	52	34	40	43	544
					Per cent of year's sales								
1917-18	5.3	4.6	3.4	3.8	8.8	12.2	14.2	16.1	13.7	7.1	5.6	5.8	100
1918-19	6.7	6.8	8.4	6.7	7.3	12.1	15.0	7.2	7.5	8.2	8.0	6.1	100
1919-20	4.5	5.6	4.9	5.6	9.2	15.0	12.9	9.5	8.7	5.9	7.6	10.6	100
1920-21	5.4	5.6	6.9	5.3	7.1	11.3	14.3	11.7	8.9	5.6	8.3	9.4	100
1921-22	4.9	7.3	8.6	6.7	6.6	12.4	13.8	12.4	7.5	4.7	7.6	7.5	100
Average	5.4	5.9	6.4	5.6	7.8	12.6	14.0	11.4	9.2	6.3	7.5	7.9	100

Table XXIV—Monthly and Yearly Receipts of Corn at Primary Markets, 1913-14 to 1921-22

Month	1913-14	1914-15	1915-16	1916-17	1917-18	1918-19	1919-20	1920-21	1921-22
November	12,485	23,165	17,614	21,645	13,412	16,113	13,232	10,374	14,105
December	38,552	42,230	26,414	27,515	18,357	17,381	22,205	18,276	42,639
January	27,763	47,599	30,362	32,398	24,551	12,405	21,239	39,991	46,537
February	23,500	25,877	36,413	21,129	39,150	12,792	24,169	26,026	59,558
March	24,988	13,016	24,173	22,466	49,591	17,843	22,969	32,514	33,930
April	9,948	13,749	16,665	15,992	28,294	9,178	10,669	11,192	13,188
May	10,784	12,554	17,768	16,332	19,010	19,560	10,894	19,196	21,965
June	24,322	14,918	13,919	23,029	19,163	12,275	25,763	34,463	35,281
July	12,313	14,367	21,275	17,155	22,292	27,125	20,102	17,949	22,475
August	20,032	13,767	15,427	14,145	16,622	8,229	9,264	30,061	24,708
September	15,031	17,191	18,359	8,361	22,746	14,809	19,852	35,578	31,123
October	10,899	15,245	12,149	8,209	23,740	11,849	18,707	34,502	28,651
Crop year total	230,617	254,678	250,538	228,376	296,928	179,559	223,065	310,122	374,160

Table XXV—Yield Per Acre of Corn Belt States and United States*

Year	Ohio	Indiana	Illinois	Minnesota	Iowa	Missouri	South Dakota	Nebraska	Kansas	United States
1891	32.0	33.3	33.5	26.5	36.7	29.9	22.5	35.2	26.7	27.0
1892	29.4	29.3	26.2	27.0	28.3	27.7	22.3	28.2	24.5	23.1
1893	23.8	24.7	25.7	28.3	33.9	27.9	23.7	25.2	21.3	22.5
1894	26.3	28.9	28.8	18.4	15.0	22.0	4.2	6.0	11.2	19.4
1895	32.6	32.8	37.4	31.2	35.1	36.0	11.1	16.1	24.3	26.2
1896	41.0	35.0	40.5	30.5	39.0	27.0	26.0	37.5	28.0	28.2
1897	32.5	30.0	32.5	26.0	29.0	26.0	24.0	30.0	18.0	23.8
1898	37.0	36.0	30.0	32.0	35.0	26.0	28.0	21.0	16.0	24.8
1899	36.0	38.0	36.0	33.0	31.0	26.0	26.0	28.0	27.0	25.3
1900	37.0	38.0	37.0	33.0	38.0	28.0	27.0	36.0	19.0	25.3
1901	26.1	19.8	21.4	26.3	25.0	10.1	21.0	14.1	7.8	16.7
1902	38.0	37.9	38.7	22.8	32.0	39.0	18.9	32.3	29.9	26.8
1903	29.6	33.2	32.2	28.3	28.0	32.4	27.2	26.0	25.6	25.5
1904	32.5	31.5	36.5	26.9	32.6	26.2	28.1	32.8	20.9	26.8
1905	37.8	40.7	39.8	32.5	34.8	33.8	31.8	32.8	27.7	28.8
1906	42.6	39.6	36.1	33.6	39.5	32.3	33.5	34.1	28.9	30.3
1907	34.6	36.0	36.0	27.0	29.5	31.0	25.5	24.0	22.1	25.9
1908	38.5	30.3	31.6	29.0	31.7	27.0	29.7	27.0	22.0	26.2
1909	39.5	40.0	35.9	34.8	31.5	26.4	31.7	24.8	19.9	25.5
1910	36.5	39.3	39.1	32.7	36.3	33.0	25.0	25.8	19.0	27.7
1911	38.6	36.0	33.0	33.7	31.0	26.0	22.0	21.0	14.5	23.9
1912	42.8	40.3	40.0	34.5	43.0	32.0	30.6	24.0	23.0	29.2
1913	37.5	36.0	27.0	40.0	34.0	17.5	25.5	15.0	3.2	23.1
1914	39.1	33.0	29.0	35.0	38.0	22.0	26.0	24.5	18.5	25.8
1915	41.5	38.0	36.0	23.0	30.0	29.5	29.0	30.0	31.0	28.2
1916	31.5	34.0	29.5	33.5	36.5	19.5	28.5	26.0	10.0	24.4
1917	38.0	36.0	38.0	30.0	37.0	35.0	28.0	27.0	13.0	26.3
1918	36.0	33.0	35.5	40.0	36.0	20.0	34.0	17.7	7.1	24.0
1919	43.0	37.0	36.0	40.0	41.6	27.0	28.5	26.2	15.2	28.9
1920	43.4	40.5	34.6	37.5	46.0	32.0	30.0	33.8	26.5	31.5
1921	41.0	36.0	34.0	41.0	43.0	30.0	32.0	28.0	22.2	29.7
1922	39.0	37.0	35.5	33.0	45.0	28.5	28.5	25.0	19.3	28.2
1923										

*Yield figures for United States on page 226 are probably more accurate than these figures but are not so comparable with these state figures.

Table XXVI—Thousands of Acres of Corn in Corn Belt States and United States*

Year	Ohio	Indiana	Illinois	Minnesota	Iowa	Missouri	South Dakota	Nebraska	Kansas	United States
1891										76,205
1892	2,852	3,527	6,310	896	7,075	5,505	794	5,572	5,952	70,627
1893										72,036
1894										62,582
1895	2,846	3,702	6,821	1,152	8,504	6,613	1,119	7,807	8,426	82,076
1896	3,017	3,813	7,026	1,129	8,249	6,547	1,197	7,962	8,848	81,027
1897	2,835	3,660	7,167	993	7,589	6,612	994	8,042	9,024	80,095
1898	2,779	3,587	6,665	954	7,285	5,951	1,003	7,559	8,303	77,722
1899	2,751	3,733	6,865	945	7,812	6,266	1,154	8,013	8,001	82,109
1900	2,889	4,032	7,139	963	8,048	6,453	1,200	8,093	8,624	83,321
1901	3,077	4,432	9,254	1,361	9,211	6,578	1,421	7,741	7,885	94,350
1902	3,200	4,520	9,623	1,484	9,302	6,775	1,577	7,451	7,817	94,044
1903	2,976	4,295	8,201	1,439	8,186	6,260	1,530	6,630	6,707	88,092
1904	3,065	4,552	9,428	1,554	9,296	5,783	1,561	7,956	6,440	92,232
1905	2,974	4,598	9,617	1,508	8,768	6,014	1,623	8,035	6,977	94,011
1906	3,325	4,643	9,617	1,492	9,450	7,075	1.875	7,325	6,750	96,738
1907	3,400	4,690	9,521	1,615	9,160	7,775	1,850	7,472	7,020	99,931
1908	3,550	4,549	9,450	1,615	9,068	7,542	1,942	7,621	7,100	101,788
1909	3,875	4,913	10,300	1,690	9,200	8,100	2,059	7,825	7,750	108,471
1910	3,960	4,800	10,250	2,040	9,470	7,500	2,100	7,425	8,950	104,035
1911	3,900	4,850	10,156	2,200	9,850	7,400	2,310	7,425	8,700	105,825
1912	4,075	4,947	10,658	2,666	10,047	7,622	2,495	7,609	7,575	107,083
1913	3,900	4,900	10,450	2,400	9,950	7,375	2,640	7,610	7,320	105,820
1914	3,650	4,949	10,346	2,600	10.248	7,200	3,000	7,100	5,850	103,435
1915	3,700	5,025	10,400	2,800	9,950	6,500	3,250	7,100	5,550	106,197
1916	3,600	5,137	10,200	2,600	10,050	6,775	2,950	7,400	6,950	105,954
1917	3,950	5,651	11,000	3,000	11,100	7,200	3,350	9,240	9,156	116,730
1918	3,790	5,138	9,900	2,750	10,434	6,693	3,182	6,954	6,130	104,461
1919	3,943	4,882	8,579	2,998	9,959	5,962	3,288	7,030	4,188	97,070
1920	3,965	4,834	9,079	3,288	10,300	6,646	3,650	7,560	5,007	101,699
1921	3,786	4,718	8,999	3,820	10,330	6,096	3,926	7,419	4,601	103,850
1922	3,823	4,765	8,819	3,979	10,123	6,150	3,061	7,296	5,098	102,428
1923										

*Acreage figures for United States on page 226 are probably more accurate than these figures but are not so comparable to these state figures.

Table XXVII—Price Per Bushel of Corn on Farm, December 1, for Corn Belt States and United States, 1891-1922*

Year	Ohio	Indiana	Illinois	Minnesota	Iowa	Missouri	South Dakota	Nebraska	Kansas	United States
1891	.41	.38	.37	.39	.30	.38	.35	.26	.34	.406
1892	.42	.40	.37	.37	.32	.36	.33	.28	.31	.394
1893	.40	.36	.31	.34	.27	.30	.25	.27	.31	.365
1894	.43	.37	.39	.43	.45	.40	.46	.50	.43	.457
1895	.27	.23	.22	.20	.18	.20	.23	.18	.19	.253
1896	.21	.19	.18	.19	.14	.20	.18	.13	.18	.215
1897	.25	.21	.21	.24	.17	.24	.21	.17	.22	.263
1898	.27	.25	.25	.24	.23	.27	.23	.22	.26	.287
1899	.30	.27	.26	.24	.23	.30	.26	.23	.25	.303
1900	.34	.32	.32	.29	.27	.32	.29	.31	.32	.357
1901	.57	.55	.57	.45	.52	.67	.45	.54	.63	.605
1902	.42	.36	.36	.40	.33	.33	.41	.30	.34	.403
1903	.47	.36	.36	.38	.38	.34	.35	.28	.36	.425
1904	.46	.41	.39	.36	.33	.44	.36	.33	.41	.441
1905	.43	.38	.38	.33	.34	.37	.31	.32	.33	.413
1906	.39	.36	.36	.34	.32	.38	.29	.29	.32	.399
1907	.52	.45	.44	.50	.43	.47	.46	.41	.44	.516
1908	.63	.60	.57	.55	.52	.57	.50	.51	.55	.606
1909	.56	.50	.52	.49	.49	.59	.50	.50	.54	.579
1910	.46	.40	.38	.45	.36	.44	.40	.36	.45	.480
1911	.58	.54	.55	.53	.53	.60	.53	.55	.63	.618
1912	.45	.42	.41	.37	.35	.46	.37	.37	.40	.487
1913	.63	.60	.63	.53	.60	.74	.56	.65	.78	.691
1914	.61	.58	.61	.52	.55	.68	.50	.53	.63	.644
1915	.56	.51	.54	.62	.51	.57	.49	.47	.51	.575
1916	.90	.84	.84	.80	.80	.90	.77	.78	.90	.889
1917	1.36	1.25	1.10	1.10	1.08	1.14	1.20	1.20	1.25	1.279
1918	1.30	1.19	1.20	1.11	1.22	1.43	1.10	1.28	1.49	1.365
1919	1.21	1.25	1.30	1.20	1.20	1.38	1.19	1.22	1.40	1.345
1920	.68	.59	.59	.51	.47	.64	.42	.41	.44	.670
1921	.41	.37	.38	.31	.30	.40	.26	.27	.31	.423
1922	.66	.56	.60	.56	.56	.68	.50	.58	.61	.657
1923										

*Price figures for United States on page 226 are probably more accurate than these figures but are not so comparable to these state figures.

Table XXVIII—Chicago Corn Prices

No. 2 mixed corn has been used throughout. From 1880 to 1916, inclusive, the average of the high and low for the month as been taken. Since January, 1917, each day of the month has been averaged. Previous to 1880, averages were taken either weekly or semi-monthly. All figures are derived either from the Howard-Bartels Red Book or the Chicago Board of Trade reports, or by averaging prices of the Howard Bartels Chicago Daily Trade Bulletin. The three sources generally agree.

	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.	10-yr. av.
January	.48	.29	.23	.47	.82	.90	.38	.70	.86	.55	.568
February	.41	.28	.23	.51	.89	.88	.35	.68	.82	.56	.561
March	.42	.27	.24	.50	.79	.79	.37	.74	.83	.54	.549
April	.46	.30	.26	.47	.92	.63	.42	.93	.82	.54	.575
May	.48	.33	.27	.48	1.04	.54	.48	.96	.88	.58	.604
June	.46	.23	.26	.48	1.15	.52	.51	.88	.85	.62	.596
July	.43	.23	.28	.48	1.30	.56	.56	.80	.88	.81	.633
August	.40	.23	.33	.49	1.26	.67	.56	.90	.97	.90	.671
September	.37	.21	.29	.60	1.30	.60	.54	1.00	.94	.84	.669
October	.38	.22	.34	.79	1.25	.49	.66	1.06	.87	.67	.673
November	.32	.22	.31	.88	1.35	.52	.87	.97	.76	.73	.693
December	.28	.24	.37	.93	.97	.43	.76	.84	.64	.76	.622
Yearly average	.407	.254	.284	.590	1.082	.628	.540	.872	.843	.675	.618

CHICAGO CORN PRICES—Continued

	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	10-yr. av.
January	.72	.47	.41	.31	.55	.66	.43	.44	.42	.30	.471
February	.70	.52	.40	.31	.58	.64	.41	.42	.40	.32	.470
March	.72	.54	.38	.32	.60	.66	.44	.40	.42	.33	.481
April	.82	.54	.40	.34	.63	.71	.47	.46	.40	.32	.509
May	.87	.54	.46	.39	.62	.71	.47	.53	.40	.34	.533
June	.83	.53	.49	.34	.60	.67	.45	.46	.36	.36	.509
July	.83	.51	.41	.36	.62	.70	.46	.48	.38	.36	.511
August	.74	.45	.41	.39	.67	.69	.45	.45	.39	.33	.497
September	.64	.47	.36	.40	.77	.59	.45	.44	.36	.35	.483
October	.60	.47	.33	.38	.76	.55	.44	.43	.34	.41	.471
November	.61	.46	.33	.38	.77	.52	.44	.45	.32	.42	.470
December	.50	.41	.31	.50	.78	.49	.45	.44	.31	.41	.460
Yearly average	.715	.492	.381	.368	.662	.632	.446	.450	.375	.354	.487

CHICAGO CORN PRICES—Continued

	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	10-yr. av.
January	.39	.37	.62	.60	.54	.37	.37	.36	.40	.34	.445
February	.37	.37	.58	.57	.54	.37	.37	.35	.47	.35	.434
March	.35	.40	.64	.56	.52	.39	.37	.37	.49	.34	.443
April	.34	.42	.74	.53	.50	.45	.37	.38	.52	.34	.459
May	.37	.43	.73	.55	.55	.47	.36	.38	.57	.34	.475
June	.36	.45	.72	.54	.54	.47	.35	.37	.51	.34	.465
July	.36	.48	.78	.50	.53	.47	.40	.36	.48	.36	.472
August	.38	.57	.77	.52	.53	.45	.42	.40	.45	.35	.484
September	.40	.67	.67	.50	.69	.43	.39	.42	.43	.33	.493
October	.40	.68	.65	.48	.50	.42	.35	.42	.43	.32	.465
November	.42	.61	.68	.52	.40	.43	.35	.44	.39	.46	.470
December	.39	.61	.55	.59	.37	.39	.37	.49	.35	.32	.443
Yearly average	.378	.505	.678	.539	.518	.426	.373	.395	.465	.349	.463

CHICAGO CORN PRICES—Continued

	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	10-yr. av.
January	.29	.49	.38	.42	.35	.43	.27	.23	.27	.37	.350
February	.28	.52	.40	.42	.35	.41	.28	.23	.29	.35	.353
March	.29	.62	.39	.41	.36	.44	.29	.24	.29	.35	.368
April	.31	.71	.41	.41	.38	.47	.30	.24	.32	.35	.390
May	.34	.62	.70	.42	.38	.52	.29	.24	.35	.33	.419
June	.34	.58	.51	.40	.40	.50	.27	.24	.32	.34	.390
July	.40	.62	.50	.39	.44	.45	.26	.26	.34	.33	.399
August	.48	.63	.52	.38	.53	.40	.23	.30	.32	.32	.411
September	.48	.58	.46	.40	.53	.34	.21	.30	.30	.33	.393
October	.51	.55	.42	.39	.51	.30	.24	.27	.31	.32	.382
November	.51	.64	.42	.37	.50	.28	.24	.27	.33	.32	.388
December	.50	.49	.41	.35	.46	.26	.23	.26	.36	.31	.363
Yearly average	.394	.588	.460	.397	.433	.400	.259	.257	.317	.335	.384

CHICAGO CORN PRICES—Continued

	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	10-yr. av.
January	.31	.37	.61	.46	.45	.43	.42	.42	.59	.60	.466
February	.33	.39	.59	.44	.50	.44	.41	.44	.58	.63	.475
March	.36	.42	.59	.44	.53	.47	.42	.44	.62	.66	.495
April	.40	.45	.61	.44	.51	.48	.46	.48	.67	.70	.520
May	.38	.51	.62	.45	.49	.56	.49	.53	.75	.74	.552
June	.40	.43	.66	.50	.49	.54	.52	.53	.71	.74	.552
July	.42	.51	.72	.51	.49	.56	.49	.54	.74	.71	.569
August	.39	.57	.57	.52	.54	.55	.51	.58	.79	.68	.570
September	.41	.57	.60	.49	.53	.53	.50	.62	.80	.66	.571
October	.39	.56	.58	.45	.54	.52	.49	.61	.73	.61	.548
November	.42	.61	.55	.43	.54	.49	.46	.58	.64	.63	.535
December	.38	.65	.51	.42	.46	.46	.46	.60	.60	.64	.518
Yearly average	.383	.504	.601	.463	.506	.503	.469	.531	.685	.667	.531

CHICAGO CORN PRICES—Continued

	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.	1918.	1919.	10-yr. av.
January	.65	.47	.67	.49	.63	.73	.76	.99	1.81	1.40	.860
February	.65	.47	.65	.50	.62	.73	.76	1.01	1.75	1.31	.845
March	.63	.47	.70	.52	.67	.73	.74	1.12	1.72	1.51	.881
April	.59	.50	.78	.56	.67	.76	.77	1.45	1.66	1.63	.937
May	.60	.54	.79	.58	.70	.77	.74	1.64	1.62	1.77	.975
June	.59	.56	.74	.61	.71	.74	.74	1.71	1.59	1.92	.991
July	.63	.63	.72	.64	.72	.79	.81	2.00	1.65	2.19	1.078
August	.63	.64	.78	.73	.80	.79	.85	1.97	1.71	1.95	1.085
September	.55	.67	.74	.75	.78	.72	.87	2.10	1.59	1.53	1.030
October	.50	.72	.64	.70	.74	.63	1.00	1.99	1.38	1.39	.969
November	.50	.73	.54	.73	.70	.65	1.02	2.10	1.37	1.51	.985
December	.48	.70	.51	.70	.65	.72	.92	1.73	1.45	1.47	.933
Yearly average	.584	.592	.689	.626	.699	.730	.832	1.650	1.608	1.632	.964

CHICAGO CORN PRICES—Continued

	1920.	1921.	1922.	1923.	1924.	1925.	1926.	1927.	1928.	1929.	10-yr. av.
January	1.50	.68	.50	.71							
February	1.46	.66	.56	.74							
March	1.59	.65	.58	.74							
April	1.71	.58	.59	.80							
May	1.98	.61	.62	.81							
June	1.86	.62	.61	.83							
July	1.56	.62	.64	.86							
August	1.56	.57	.62								
September	1.34	.55	.64								
October	.90	.47	.70								
November	.78	.48	.72								
December	.72	.49	.74								
Yearly average	1.41	.582	.626								

Table XXIX—Chicago Heavy Hog Prices

From 1896 to date, heavy hog prices, as compiled by Chas. A. S. McCracken for the Chicago Drovers' Journal Year-Book, have been used. From 1881 to 1895, inclusive, the average of the range of Chicago hog prices, as compiled by the Cincinnati Price Current, has been used. Properly speaking, these prices refer more nearly to average hogs than to heavy hogs. Previous to 1881, prices have been compiled from the Chicago Board of Trade reports, the grade known as heavy packers and shippers being used so far as possible.

	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.	10-yr. av.
January	4.85	5.05	2.35	3.60	5.90	11.15	9.30	6.10	6.60	10.15	6.51
February	5.25	5.00	2.50	4.05	6.35	11.30	9.45	6.50	7.75	10.35	6.85
March	5.05	4.75	3.00	4.15	6.55	11.15	9.40	6.60	8.65	9.85	6.92
April	4.90	4.55	2.90	4.25	6.95	9.50	8.55	6.80	8.55	9.75	6.67
May	4.80	3.85	2.50	3.75	6.45	7.50	8.70	6.25	8.25	8.75	6.08
June	4.80	3.10	2.40	4.15	7.25	7.80	8.95	5.90	7.65	8.75	6.08
July	5.20	2.70	2.55	4.25	8.55	9.25	9.40	6.05	8.35	8.95	6.53
August	5.35	2.75	2.60	3.80	8.90	10.85	9.85	6.35	9.15	9.20	6.88
September	5.30	2.80	2.90	4.20	9.50	11.70	9.30	6.15	8.70	9.25	6.98
October	5.30	2.80	2.90	4.10	8.65	12.20	8.65	5.85	7.50	9.30	6.73
November	5.30	2.65	3.45	4.50	9.75	11.15	6.95	5.75	7.00	9.10	6.56
December	4.60	2.45	3.80	5.05	10.05	9.05	5.85	6.60	8.35	9.80	6.56
Yearly average	5.06	3.54	2.83	4.16	7.91	10.23	8.69	6.24	8.04	9.44	6.61

CHICAGO HEAVY HOG PRICES—Continued

	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	10-yr. av.
January	9.05	6.60	4.35	3.85	5.20	6.60	7.15	6.45	4.05	2.90	5.62
February	9.00	7.30	4.45	4.20	5.35	6.95	7.95	6.15	3.90	3.70	5.90
March	8.55	6.75	4.45	4.95	5.30	7.50	8.55	5.50	3.70	3.95	5.92
April	8.80	5.60	4.25	5.40	5.50	8.25	8.05	5.55	3.55	3.70	5.87
May	8.75	4.55	4.05	4.90	5.50	7.90	7.15	5.30	3.30	3.50	5.49
June	8.60	3.80	3.90	4.45	5.55	7.00	6.05	4.85	3.50	3.75	5.15
July	9.00	4.40	4.05	4.55	6.05	7.05	7.00	4.95	4.10	3.60	5.48
August	9.50	4.40	4.65	4.60	6.90	7.75	6.15	5.05	4.25	3.40	5.67
September	9.30	4.45	4.90	4.50	7.25	8.00	6.00	5.30	3.95	3.45	5.71
October	7.90	4.30	4.60	4.30	6.00	7.95	5.90	5.35	3.45	3.60	5.34
November	6.85	4.00	4.25	3.85	6.50	7.30	5.75	4.70	2.95	3.85	5.00
December	6.15	4.15	3.75	4.70	6.85	6.95	5.95	4.25	2.70	4.55	5.00
Yearly average	8.46	5.03	4.31	4.53	6.00	7.44	6.81	5.29	3.62	3.67	5.51

CHICAGO HEAVY HOG PRICES—Continued

	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	10-yr. av.
January	4.60	5.15	6.60	6.35	5.85	4.60	3.85	4.45	5.40	5.00	5.19
February	4.45	5.90	6.80	6.90	6.70	4.60	4.05	5.20	5.35	4.70	5.47
March	4.45	5.90	6.80	7.25	6.50	4.55	4.15	5.30	5.45	4.75	5.51
April	4.50	5.95	7.10	7.50	5.95	4.55	4.00	5.00	5.50	4.75	5.48
May	4.30	6.05	7.70	7.30	5.55	4.05	4.00	4.60	5.55	4.50	5.36
June	4.30	5.90	7.90	6.50	5.20	4.00	4.15	4.55	5.55	4.35	5.24
July	4.55	6.40	8.20	5.65	5.25	4.55	4.60	5.30	6.10	4.40	5.50
August	4.95	6.50	8.45	5.50	5.70	4.55	4.45	4.75	6.20	4.15	5.52
September	5.25	6.75	8.40	5.20	5.20	4.10	4.35	5.00	6.20	4.20	5.47
October	4.85	6.60	7.65	4.70	4.70	3.80	4.10	4.50	6.05	4.25	5.12
November	4.75	6.20	6.75	4.75	4.45	3.50	3.75	4.85	5.95	3.85	4.88
December	4.75	6.15	6.20	5.20	4.20	3.65	4.25	5.20	5.20	3.60	4.84
Yearly average	4.64	6.13	7.38	6.07	5.44	4.21	4.14	4.89	5.71	4.38	5.30

CHICAGO HEAVY HOG PRICES—Continued

	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	10-yr. av.
January	3.70	3.55	4.25	7.45	5.30	4.25	3.95	3.35	3.65	3.75	4.32
February	3.95	3.50	4.60	7.95	5.10	4.15	4.10	3.35	4.00	3.80	4.45
March	4.10	4.20	4.55	7.55	4.75	4.60	3.90	3.85	3.90	3.80	4.52
April	4.25	4.80	4.50	7.05	5.00	4.90	3.55	4.05	3.90	3.85	4.59
May	4.05	4.65	4.55	7.40	4.90	4.55	3.30	3.75	4.35	3.90	4.54
June	3.75	4.50	5.00	6.65	4.75	4.65	3.15	3.40	4.10	3.80	4.38
July	3.75	5.10	5.65	5.60	5.30	5.10	3.05	3.50	3.95	4.25	4.53
August	3.80	5.10	5.40	5.05	5.35	4.65	3.05	3.90	3.90	4.55	4.48
September	4.35	4.90	5.15	6.00	5.85	4.10	2.90	4.00	3.85	4.40	4.55
October	4.05	4.50	5.35	6.40	5.15	3.85	3.25	3.75	3.70	4.30	4.43
November	3.30	3.85	5.50	5.70	4.35	3.55	3.25	3.40	3.45	3.90	4.08
December	3.40	3.65	6.15	5.65	4.35	3.50	3.25	3.35	3.40	4.05	4.08
Yearly average	3.92	4.36	5.06	6.54	5.02	4.33	3.39	3.64	3.85	4.03	4.41

CHICAGO HEAVY HOG PRICES—Continued

	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	10-yr. av.
January	4.55	5.25	6.40	6.60	4.95	4.70	5.40	6.60	4.45	6.20	5.51
February	4.90	5.40	6.30	7.00	5.25	4.90	6.00	7.05	4.50	6.45	5.78
March	5.00	5.90	6.50	7.45	5.50	5.20	6.30	6.65	5.05	6.80	6.04
April	5.55	5.85	7.10	7.30	5.15	5.45	6.50	6.60	5.85	7.30	6.27
May	5.30	5.80	7.00	6.60	4.75	5.40	6.45	6.35	5.50	7.40	6.06
June	5.20	6.00	7.50	6.05	5.05	5.30	6.55	6.05	5.80	7.80	6.13
July	5.25	5.90	7.80	5.45	5.35	5.60	6.60	5.90	6.55	7.90	6.23
August	5.20	5.95	7.25	5.30	5.25	5.90	6.15	5.90	6.60	7.60	6.11
September	5.25	6.65	7.55	5.75	5.70	5.40	6.15	5.80	6.90	8.10	6.33
October	4.80	6.10	7.00	5.40	5.35	5.10	6.40	6.05	6.05	7.85	6.01
November	4.80	5.70	6.35	4.60	4.80	4.80	6.20	4.90	5.90	8.10	5.62
December	4.75	6.20	6.35	4.50	4.50	4.90	6.25	4.65	5.75	8.45	5.63
Yearly average	5.05	5.89	6.93	6.00	5.14	5.23	6.25	6.04	5.74	7.50	5.97

CHICAGO HEAVY HOG PRICES—Continued

	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.	1918.	1919.	10-yr. av.
January	8.70	7.85	6.30	7.40	8.35	6.80	7.30	11.00	16.40	17.60	9.77
February	9.20	7.25	6.25	8.05	8.55	6.70	8.30	12.50	16.70	17.65	10.12
March	10.65	6.70	7.10	8.75	8.60	6.65	9.60	14.90	17.00	19.00	10.91
April	10.00	6.15	7.85	8.80	8.50	7.05	9.70	15.80	17.40	20.30	11.16
May	9.50	5.85	7.70	8.40	8.30	7.40	9.85	16.00	17.45	20.60	11.11
June	9.35	6.15	7.50	8.50	8.15	7.35	9.75	15.65	16.50	20.30	10.92
July	8.60	6.65	7.60	8.95	8.60	6.95	9.75	15.20	17.70	21.65	11.17
August	8.25	7.15	8.05	8.10	8.75	6.70	10.20	17.00	18.90	19.75	11.29
September	8.70	6.75	8.30	8.10	8.60	7.20	10.55	18.30	19.55	17.25	11.33
October	8.45	6.50	8.65	8.15	7.55	7.75	9.85	17.25	17.55	14.25	10.60
November	7.75	6.35	7.75	7.80	7.50	6.85	9.85	17.60	17.70	14.10	10.31
December	7.65	6.25	7.45	7.70	7.10	6.60	10.00	16.95	17.55	13.50	10.08
Yearly average	8.89	6.64	7.54	8.23	8.22	7.00	9.56	15.68	17.53	18.00	10.73

CHICAGO HEAVY HOG PRICES—Continued

	1920.	1921.	1922.	1923.	1924.	1925.	1926.	1927.	1928.	1929.	10-yr. av.
January	14.90	9.25	7.80								
February	14.30	9.10	9.60								
March	14.65	9.60	10.20								
April	14.40	8.25	10.15								
May	14.00	8.20	10.25								
June	14.35	8.10	10.10								
July	14.50	9.50	9.40								
August	14.45	9.15	8.15								
September	15.55	7.40	8.50								
October	13.70	7.40	8.60								
November	12.00	7.50	7.90								
December	9.40	6.75	8.00								
Yearly average	13.85	8.35	9.06								

Table XXX--Chicago Corn-Hog Ratios by Decades

	1870-1879.	1880-1889.	1890-1899.	1900-1909.	1910-1919.						50-yr. av.
January	11.9	11.7	12.3	11.8	11.4						11.8
February	12.6	12.6	12.6	12.2	12.0						12.4
March	12.3	12.4	12.3	12.2	12.4						12.3
April	11.5	11.9	11.8	12.1	11.9						11.8
May	10.3	11.3	10.8	11.0	11.4						10.9
June	10.1	11.3	11.2	11.1	11.0						10.9
July	10.7	11.7	11.4	11.0	10.4						11.0
August	11.4	11.4	10.9	10.7	10.3						10.9
September	11.8	11.1	11.6	11.1	11.1						11.3
October	11.3	11.0	11.6	11.0	11.0						11.2
November	10.6	10.2	10.5	10.5	10.6						10.5
December	10.9	10.9	11.2	10.9	10.5						10.9

Table XXXI—Iowa Corn Prices

(Prices on farms or nearest shipping point, first of each month)

	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.	1918.	1919.	10-yr. av.
January	.51	.36	.52	.36	.58	.57	.57	.80	1.21	1.36	.684
February	.54	.37	.55	.38	.56	.66	.62	.88	1.21	1.25	.702
March	.52	.37	.56	.39	.56	.65	.61	.92	1.34	1.22	.714
April	.51	.38	.61	.41	.59	.64	.65	1.11	1.36	1.40	.766
May	.48	.41	.69	.45	.59	.68	.66	1.40	1.40	1.54	.830
June	.50	.44	.70	.50	.63	.68	.68	1.46	1.35	1.63	.857
July	.53	.49	.67	.52	.63	.69	.69	1.56	1.37	1.66	.881
August	.55	.56	.65	.54	.64	.71	.73	2.02	1.47	1.84	.971
September	.56	.56	.67	.66	.72	.71	.77	1.65	1.50	1.69	.949
October	.49	.57	.61	.66	.69	.66	.76	1.70	1.38	1.32	.884
November	.39	.57	.50	.60	.61	.59	.78	1.36	1.15	1.11	.766
December	.36	.53	.35	.60	.55	.51	.80	1.08	1.22	1.20	.720
Yearly average	.495	.467	.590	.506	.612	.646	.693	1.328	1.330	1.435	.810

IOWA CORN PRICES—Continued

(Prices on farms or nearest shipping point, first of each month.)

	1920.	1921.	1922.	1923.	1924.	1925.	1926.	1927.	1928.	1929.	10-yr. av.
January	1.23	.51	.32	.59							
February	1.29	.44	.35	.58							
March	1.28	.48	.47	.62							
April	1.41	.43	.45	.62							
May	1.53	.40	.48	.69							
June	1.69	.44	.49	.71							
July	1.66	.45	.50	.73							
August	1.36	.45	.51								
September	1.35	.40	.49								
October	.95	.36	.50								
November	.64	.27	.53								
December	.47	.30	.56								
Yearly average	1.238	.412	.471								

Table XXXII—Illinois Corn Prices

(Prics on farms or nearest shipping point, first of each month.)

	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.	1918.	1919.	10-yr. av.
January	.55	.39	.55	.41	.64	.64	.62	.84	1.16	1.34	.714
February	.59	.40	.59	.45	.60	.70	.65	.92	1.25	1.20	.735
March	.59	.40	.60	.46	.60	.68	.65	.98	1.36	1.23	.755
April	.57	.40	.65	.47	.64	.69	.65	1.09	1.30	1.42	.788
May	.54	.43	.74	.51	.63	.74	.69	1.47	1.33	1.56	.864
June	.54	.47	.77	.55	.68	.73	.69	1.54	1.25	1.67	.889
July	.57	.51	.73	.58	.68	.72	.70	1.60	1.32	1.74	.915
August	.58	.58	.71	.61	.72	.76	.76	2.06	1.39	1.89	1.016
September	.57	.60	.72	.73	.78	.73	.80	1.72	1.47	1.84	.996
October	.51	.61	.66	.71	.74	.68	.80	1.80	1.39	1.41	.930
November	.43	.60	.50	.64	.67	5.7	.84	1.42	1.18	1.24	.809
December	.38	.55	.41	.63	.61	.54	.84	1.10	1.20	1.30	.756
Yearly average	.535	.495	.636	.563	.666	.681	.724	1.378	1.300	1.487	.847

ILLINOIS CORN PRICES—Continued

(Prices on farms or nearest shipping point, first of each month..)

	1920.	1921.	1922.	1923.	1924.	1925.	1926.	1927.	1928.	1929.	10-yr. av.
January	1.37	.61	.39	.64							
February	1.44	.54	.41	.64							
March	1.42	.55	.50	.67							
April	1.54	.53	.49	.68							
May	1.69	.51	.53	.76							
June	.184	.56	.54	.76							
July	.183	.53	.55	.78							
August	1.48	.55	.56								
September	1.49	.48	.55								
October	1.09	.44	.56								
November	.77	.35	.56								
December	.59	.38	.60								
Yearly average	1.379	.500	.520								

Table XXXIII—Corn (American Mixed)—Average Spot Prices Per Bushel of 56 Pounds at Liverpool*

	1912.	1913.	1914.	1915.	1916.	1917.	1918.	1919.	1920.	1921.	1922.
January	.92	.82	.91	1.04	1.40	1.95	2.16	2.11	†	1.49	.81
February	.95	.82	.91	1.11	1.47	2.00	2.16	2.11	1.93	1.15	.90
March	.94	.81	.91	1.10	1.43	2.05	2.16	1.65	2.14	1.13	.85
April	.95	.82	.91	1.09	1.43	1.98	2.16	1.63	2.16	1.01	.83
May	.95	.82	.91	1.13	1.47	2.03	2.16	1.63	2.04	.95	.84
June	.95	.82	.92	1.08	1.28	2.05	2.16	1.61	2.06	.97	.84
July	.93	.82	.93	1.10	1.37	2.05	2.34	1.55	†	.98	.98
August	.99	.90	1.13	1.18	1.44	2.05	2.52	†	†	.92	.92
September	.99	.95	1.11	1.16	1.41	2.05	2.52	†	†	.85	.90
October	.99	.89	1.04	1.16	1.48	2.05	2.52	†	1.63	.71	1.00
November	.91	.90	1.00	†	1.71	2.05	2.53	†	1.58	.78	1.00
December	.86	.91	.98	1.23	1.83	2.05	2.53	†	1.38	.85	1.00

*Broomhall's Corn Trade News.
†No quotations.

Table XXXIV—Corn—Spot Prices Per Bushel of 56 Pounds at Buenos Aires*

	1912.	1913.	1914.	1915.	1916.	1917.	1918.	1919.	1920.	1921.	1922.
January	†	.54	.55	.54	.56	1.07	.79	.57	.70	.88	.63
February	†	.54	.56	.61	.60	1.07	.79	.52	.71	.91	.73
March	†	.54	.56	.56	.56	.99	.74	.47	.83	.91	.79
April	.58	.56	.54	.57	.51	1.03	.59	.55	1.03	.78	.77
May	.53	.55	.59	.54	.45	1.27	.53	.55	1.13	.61	.75
June	.52	.55	.55	.50	.43	1.46	.57	.55	1.10	.63	.71
July	,51	.55	.57	.51	.45	1.43	.64	.96	.96	.65	.78
August	.52	.55 ‡	.56	.49	.51	1.27	.68	1.07	.90	.66	.78
September	.50	.62	.55	.51	.55	.87	.65	.91	.92	.65	.76
October	.51	.59	.49	.51	.70	.85	.63	.79	.83	.58	.74
November	.52	.58	.53	.54	1.03	.95	.63	.74	.77	.61	.70
December	.53	.58	.54	.52	.93	.88	.63	.71	.82	.63	.74
Average	.52	.56	.55	.53	.61	1.10	.66	.70	.89	.71	.74

*International Yearbook of Agricultural Statistics, 1912-1921. Review of the River Plata, 1922. Average of weekly quotations.
†No quotations.
‡Interpolation, no quotation.

Table XXXV—Corn—Spot Prices Per Bushel of 56 Pounds of Yellow La Plata at Liverpool*

	1912.	1913.	1914.	1915.	1916.	1917.	1918.	1919.	1920.	1921.	1922.
January	†	.71	.65	.98	1.40	‡1.89	2.23	2.04	§1.49	1.28	.92
February	†	.75	.66	1.06	1.44	1.92	2.23	2.04	‖1.77	1.22	1.08
March	†	.76	.68	1.02	1.42	2.00	2.23	1.75	‖1.96	1.30	1.08
April	†	.74	.68	1.06	1.43	2.16	2.23	1.74	1.97	1.28	1.03
May	.97	.72	.74	1.11	1.47	†	2.23	1.74	1.81	1.18	1.06
June	.87	.69	.76	.97	1.33	2.17	2.23	1.72	1.67	1.09	1.01
July	.71	.67	.78	.92	1.45	2.17	2.42	1.65	1.53	1.05	1.10
August	.75	.67	.97	.90	1.54	2.17	2.61	1.65	1.43	.93	1.10
September	.78	.70	.93	.85	1.39	2.17	2.61	1.69	1.60	.83	1.09
October	.72	.66	.83	.94	1.48	2.17	2.61	1.68	1.49	.72	1.08
November	.68	.63	.78	1.06	1.69	2.17	2.61	1.65	1.15	.78	.96
December	.67	.67	.83	1.19	1.81	2.17	2.61	1.52	1.25	.88	1.00
Average	.77	.70	.77	1.00	1.49	2.11	2.40	1.74	1.59	1.04	1.04

*Statement prepared by Foreign Section, Division of Statistical and Historical Research, Bureau of Agricultural Economics.
†Not quoted.
‡Trading in maize controlled January 5, 1917.
§Afloat price.
‖Nominal.

1922 Cost of Producing Corn

(Averages by Geographical Divisions)

	North Atlantic	South Atlantic	East-North Central	West-North Central	South Central	Western	United States
Number of reports	256	557	669	881	881	119	3,363
Acres in the crop, per farm	8.6	30.0	31.8	52.3	34.4	21.4	25.6
Yield per acre, bushels	52	30	56	34	26	30	35
Cost per acre—							
Prepare and plant	$ 8.40	$ 4.67	$ 4.71	$ 3.15	$ 3.51	$ 4.20	$ 4.25
Cultivate	4.62	3.85	2.85	2.34	3.50	2.07	3.16
Harvest	7.17	3.02	3.75	2.49	1.89	2.87	3.05
Market	2.88	2.44	2.36	1.96	2.34	3.58	2.30
Miscellaneous labor	.88	.32	.50	.31	.14	.86	.37
Fertilizer and manure	15.89	5.31	4.76	1.64	2.14	1.00	4.07
Seed	.79	.42	.46	.39	.40	.48	.44
Land rent	6.30	5.80	6.70	5.32	5.24	4.99	5.72
Miscellaneous costs	2.84	1.82	2.13	1.40	1.36	2.13	1.73
Total	49.77	27.65	28.22	19.00	20.52	22.18	25.09
Credit for by-products per acre	6.68	2.64	2.39	1.11	1.14	2.04	2.08
Net cost per acre	43.09	25.01	25.83	17.89	19.38	20.14	23.01
Net cost per bushel	.83	.83	.56	.53	.75	.67	.66
Value of product per acre	44.37	27.13	30.11	19.42	21.94	23.41	25.44
Value of product per bushel	.85	.90	.65	.57	.84	.78	.73

Iowa Rainfall in Inches

Year	March	April	May	June	July	August	September
1890	1.57	1.80	3.56	7.76	1.98	3.41	2.97
1891	2.60	2.15	3.18	5.39	4.22	4.24	1.33
1892	2.22	4.75	8.77	5.19	5.29	2.24	1.53
1893	2.14	4.21	3.45	3.91	3.33	2.32	2.34
1894	2.03	3.07	1.87	2.67	.63	1.58	3.57
1895	.83	2.62	3.19	4.32	3.40	4.43	3.03
1896	1.10	5.02	6.69	3.11	6.90	3.52	4.09
1897	2.39	5.35	1.92	3.81	3.26	1.86	2.04
1898	1.94	2.56	4.67	4.72	2.98	3.44	2.69
1899	1.62	2.40	6.23	5.04	3.07	3.68	.93
1900	2.06	2.67	3.31	3.98	6.15	4.65	4.98
1901	2.64	1.79	2.35	3.71	2.34	1.29	4.77
1902	1.45	1.71	5.39	7.16	8.67	6.58	4.35
1903	1.38	2.98	8.55	2.86	4.83	6.64	3.81
1904	2.18	3.63	3.78	3.45	4.41	3.43	2.78
1905	2.04	3.03	5.95	5.53	2.91	4.05	3.81
1906	2.34	2.42	3.54	3.92	3.04	3.95	4.16
1907	1.35	1.32	3.48	5.35	7.27	4.33	2.75
1908	1.58	2.24	8.34	5.66	3.66	4.77	1.20
1909	1.53	4.58	4.34	6.41	4.77	1.81	3.58
1910	.17	1.48	3.41	1.99	1.86	3.88	3.59
1911	.93	3.09	3.76	1.82	2.27	3.32	5.12
1912	2.01	2.66	3.33	2.74	3.71	3.78	3.98
1913	2.48	3.28	6.24	3.31	1.82	2.68	3.31
1914	1.69	2.52	3.31	5.57	2.27	2.19	7.88
1915	.96	1.41	7.34	4.16	8.32	2.81	6.03
1916	1.57	2.62	4.93	3.71	1.78	2.58	3.89
1917	1.84	4.55	3.87	6.65	2.27	2.29	2.90
1918	.63	2.32	6.87	5.29	3.17	3.61	1.87
1919	2.33	4.78	3.11	6.13	2.86	2.59	5.34
1920	3.02	4.59	3.26	3.56	4.22	3.35	3.30
1921	1.57	3.34	4.23	3.76	2.53	5.04	6.72
1922	1.97	3.06	3.53	1.82	6.31	3.06	2.03
1923	2.87	2.09	2.84	4.93	1.75	5.42	
1924							
1925							
1926							

Iowa Temperature in Degrees Fahrenheit

Year	March	April	May	June	July	August	September
1890			57.7	72.7	75.6	68.4	59.3
1891			58.3	69.1	68.5	69.1	67.3
1892			54.0	69.2	73.0	71.4	64.7
1893	31.8	45.5	56.6	71.2	75.0	69.4	64.7
1894	41.0	51.7	61.1	73.2	76.4	74.6	65.1
1895	34.4	54.2	61.4	69.7	72.1	71.9	66.8
1896	30.9	54.5	65.5	69.1	73.6	71.7	58.5
1897	32.0	47.9	58.5	69.1	75.6	68.9	70.9
1898	37.5	48.1	59.6	71.4	73.4	71.2	65.3
1899	23.0	48.9	60.2	70.7	73.1	74.4	62.5
1900	30.7	52.2	63.2	69.7	73.4	77.4	64.4
1901	34.2	44.9	60.7	72.3	82.4	73.8	63.3
1902	39.1	48.2	63.8	65.2	73.1	69.1	59.1
1903	38.8	49.8	61.6	64.6	72.9	69.1	60.8
1904	34.8	44.1	59.6	67.1	70.6	69.1	64.0
1905	41.5	47.5	58.3	69.9	70.6	74.3	65.8
1906	27.1	52.5	60.8	67.9	70.9	74.1	67.2
1907	40.6	41.5	53.5	66.5	73.7	71.1	62.8
1908	37.9	50.5	59.4	67.1	73.0	70.0	67.9
1909	32.5	43.8	57.9	69.1	72.3	76.1	62.4
1910	48.9	52.5	55.4	69.5	74.5	71.9	63.2
1911	39.4	46.7	64.9	75.7	75.5	71.7	65.8
1912	24.9	49.9	62.7	66.2	74.6	71.0	62.1
1913	31.9	50.2	59.4	71.5	76.1	76.6	64.5
1914	34.7	48.6	62.2	72.2	76.6	73.7	64.5
1915	29.3	57.2	56.1	65.1	69.5	65.9	63.7
1916	35.2	47.1	59.9	64.5	79.7	74.0	62.5
1917	34.6	45.5	55.1	66.0	74.3	69.4	62.6
1918	42.9	44.8	64.9	70.8	73.1	76.0	58.6
1919	37.5	48.4	58.2	71.9	77.4	71.5	67.5
1920	38.0	42.4	59.4	70.7	72.3	69.3	66.5
1921	42.8	52.4	63.3	74.7	77.9	72.1	67.3
1922	38.3	49.9	63.4	72.2	71.5	73.8	67.1
1923	29.4	48.4	59.6	70.9	76.5	70.6	
1924							
1925							
1926							

Illinois Rainfall in Inches

Year	March	April	May	June	July	August	September
1890	3.92	3.64	3.97	5.31	1.73	2.85	2.74
1891	3.15	3.18	2.25	4.19	2.01	4.74	1.07
1892	2.14	6.43	8.14	5.86	3.86	2.37	1.97
1893	3.12	7.69	4.34	3.45	1.92	.98	3.07
1894	2.82	2.75	3.28	2.26	1.46	1.77	4.94
1895	1.62	2.08	2.38	2.77	5.36	2.85	2.88
1896	1.84	2.96	5.78	3.88	6.35	2.80	5.46
1897	5.96	4.26	1.93	4.57	3.45	1.12	1.02
1898	7.29	3.26	5.78	4.34	2.93	4.41	4.86
1899	2.99	1.54	6.06	2.75	3.74	2.57	2.04
1900	1.99	1.54	4.22	4.41	4.19	3.87	3.55
1901	3.46	1.65	1.89	3.31	2.39	1.84	1.96
1902	3.39	2.39	4.18	8.01	4.79	4.37	4.07
1903	3.02	4.29	3.19	2.86	3.72	4.46	3.79
1904	6.23	3.71	3.41	3.09	4.62	4.07	5.05
1905	2.27	3.64	4.41	3.39	4.86	3.45	3.08
1906	3.84	2.07	2.70	3.25	2.36	3.98	5.00
1907	3.08	2.75	4.02	4.46	5.72	5.47	2.64
1908	3.11	4.40	7.76	2.86	3.40	2.45	1.29
1909	2.34	6.24	4.01	4.15	4.52	2.22	3.69
1910	.26	3.44	4.96	2.29	4.11	2.70	4.54
1911	1.72	5.06	1.92	2.77	2.34	4.19	8.74
1912	3.28	4.90	3.84	3.27	4.26	4.04	2.88
1913	5.53	2.83	3.09	2.49	2.23	2.37	2.94
1914	2.22	2.22	2.30	2.61	1.49	3.43	3.83
1915	.84	1.35	6.99	4.79	6.69	6.09	4.22
1916	1.96	1.64	4.69	5.56	1.25	4.15	2.92
1917	2.85	4.76	4.22	5.48	2.86	2.66	2.61
1918	.96	5.39	5.21	3.49	2.38	3.82	3.77
1919	3.44	2.50	5.22	4.61	1.93	2.87	3.57
1920	5.01	4.42	4.99	2.15	2.47	2.91	2.70
1921	5.13	4.81	2.09	3.75	1.84	5.12	6.62
1922	6.32	5.05	3.59	1.49	3.69	1.70	1.94
1923	4.34	2.39	4.33	3.50			
1924							
1925							
1926							

Illinois Temperature in Degrees Fahrenheit

Year	March	April	May	June	July	August	September
1890	33.1	53.1	59.3	75.4	75.9	70.5	61.9
1891	34.0	53.8	59.2	72.0	71.0	71.6	69.4
1892	35.9	49.4	58.6	71.7	74.3	73.4	65.1
1893	38.0	50.6	59.3	72.3	77.8	72.7	67.9
1894	45.8	53.8	61.5	75.0	76.3	74.7	67.5
1895	39.0	54.8	63.8	74.8	74.1	75.0	70.7
1896	35.6	59.0	69.5	71.4	75.2	73.3	6[illegible].9
1897	39.5	50.4	59.3	71.0	77.0	71.7	71.3
1898	43.4	49.6	62.2	73.3	75.5	73.8	69.3
1899	34.3	53.8	64.0	73.3	75.3	76.3	65.4
1900	35.2	53.5	64.8	71.1	75.5	79.8	69.4
1901	39.5	50.0	61.6	74.9	82.2	74.8	66.7
1902	43.1	50.8	67.2	69.6	76.2	71.9	63.0
1903	45.5	52.8	65.2	66.3	75.9	72.7	64.8
1904	40.0	46.8	62.2	69.7	73.2	70.8	67.3
1905	45.4	51.9	63.1	72.6	73.1	75.0	68.3
1906	31.1	55.3	63.8	70.5	73.8	76.3	70.7
1907	47.7	44.1	56.7	68.4	75.7	72.9	65.7
1908	44.6	52.5	63.3	70.5	75.4	74.0	70.4
1909	39.4	50.3	60.3	71.9	73.4	77.2	65.0
1910	51.9	53.4	58.0	70.1	76.3	73.3	66.9
1911	41.9	50.0	68.2	75.5	76.2	73.2	69.6
1912	30.9	53.4	64.8	68.4	75.7	72.6	67.9
1913	37.4	52.4	62.9	73.9	78.3	78.1	67.1
1914	38.3	52.7	65.3	75.5	79.0	76.0	66.8
1915	35.5	58.9	59.8	68.5	72.8	67.7	68.5
1916	38.6	50.9	63.6	67.2	80.8	77.0	65.1
1917	42.0	49.8	56.6	68.5	75.1	71.8	65.0
1918	47.4	47.9	67.1	72.1	73.8	78.8	60.0
1919	42.7	53.4	59.8	75.0	78.7	73.6	69.9
1920	42.3	47.3	61.4	72.1	74.5	72.6	69.7
1921	50.0	55.6	65.5	76.6	80.7	74.2	71.6
1922	42.9	53.9	66.5	73.9	75.0	75.1	70.3
1923	37.2	51.2	60.9	73.2			
1924							
1925							
1926							

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